



US009385077B2

(12) **United States Patent**
Kim et al.

(10) **Patent No.:** **US 9,385,077 B2**
(45) **Date of Patent:** **Jul. 5, 2016**

(54) **INTEGRATED DEVICE COMPRISING
COAXIAL INTERCONNECT**

USPC 438/117, 118, 119, 637, 639, 666, 667,
438/672

(71) Applicant: **QUALCOMM Incorporated**, San
Diego, CA (US)

See application file for complete search history.

(72) Inventors: **Dong Wook Kim**, San Diego, CA (US);
Young Kyu Song, San Diego, CA (US);
Kyu-Pyung Hwang, San Diego, CA
(US); **Hong Bok We**, San Diego, CA
(US)

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,476,476 B1 11/2002 Glenn
6,623,279 B2 9/2003 Derian et al.

(Continued)

(73) Assignee: **QUALCOMM Incorporated**, San
Diego, CA (US)

FOREIGN PATENT DOCUMENTS

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 6 days.

DE 102005002707 B4 7/2007
EP 2244291 A1 10/2010

OTHER PUBLICATIONS

(21) Appl. No.: **14/329,646**

International Search Report and Written Opinion—PCT/US2015/
039678—ISA/EPO—Sep. 24, 2015.

(22) Filed: **Jul. 11, 2014**

Primary Examiner — Kevin M Picardat

(65) **Prior Publication Data**

US 2016/0013125 A1 Jan. 14, 2016

(74) *Attorney, Agent, or Firm* — Loza & Loza, LLP

(51) **Int. Cl.**

H01L 21/44 (2006.01)

H01L 23/498 (2006.01)

H01L 21/48 (2006.01)

H05K 1/02 (2006.01)

(Continued)

(57) **ABSTRACT**

Some novel features pertain to an integrated device that includes a substrate, a first interconnect coupled to the substrate, and a second interconnect surrounding the first interconnect. The second interconnect may be configured to provide an electrical connection to ground. In some implementations, the second interconnect includes a plate. In some implementations, the integrated device also includes a dielectric material between the first interconnect and the second interconnect. In some implementations, the integrated device also includes a mold surrounding the second interconnect. In some implementations, the first interconnect is configured to conduct a power signal in a first direction. In some implementations, the second interconnect is configured to conduct a grounding signal in a second direction. In some implementations, the second direction is different from the first direction. In some implementations, the integrated device may be a package-on-package (PoP) device.

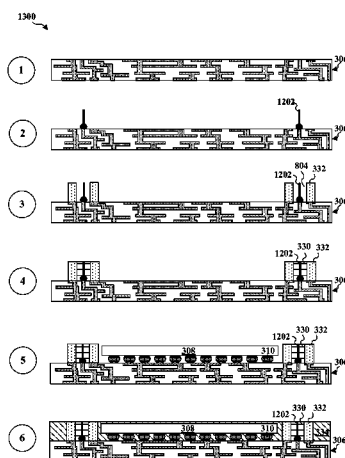
(52) **U.S. Cl.**

CPC **H01L 23/49838** (2013.01); **H01L 21/4853**
(2013.01); **H01L 23/49811** (2013.01); **H05K**
1/0298 (2013.01); **H05K 3/284** (2013.01);
H05K 3/46 (2013.01); **H01L 2224/16225**
(2013.01); **H01L 2924/15311** (2013.01); **H01L**
2924/19107 (2013.01); **H05K 2203/1316**
(2013.01)

(58) **Field of Classification Search**

CPC H01L 21/4853; H01L 23/49838;
H01L 23/49811; H05K 1/0222; H05K 1/0298;
H05K 3/284; H05K 3/46

29 Claims, 17 Drawing Sheets



-
- (51) **Int. Cl.** 7,919,870 B2 4/2011 Trezza
H05K 3/28 (2006.01) 7,952,196 B1 5/2011 Iannotti et al.
H05K 3/46 (2006.01) 2010/0164062 A1* 7/2010 Wang H01L 21/76898
257/532
- (56) **References Cited** 2012/0313226 A1 12/2012 Koizumi et al.
2013/0105987 A1* 5/2013 Gallegos H05K 1/0222
257/774

U.S. PATENT DOCUMENTS

7,557,445 B2 7/2009 Choi et al.

* cited by examiner

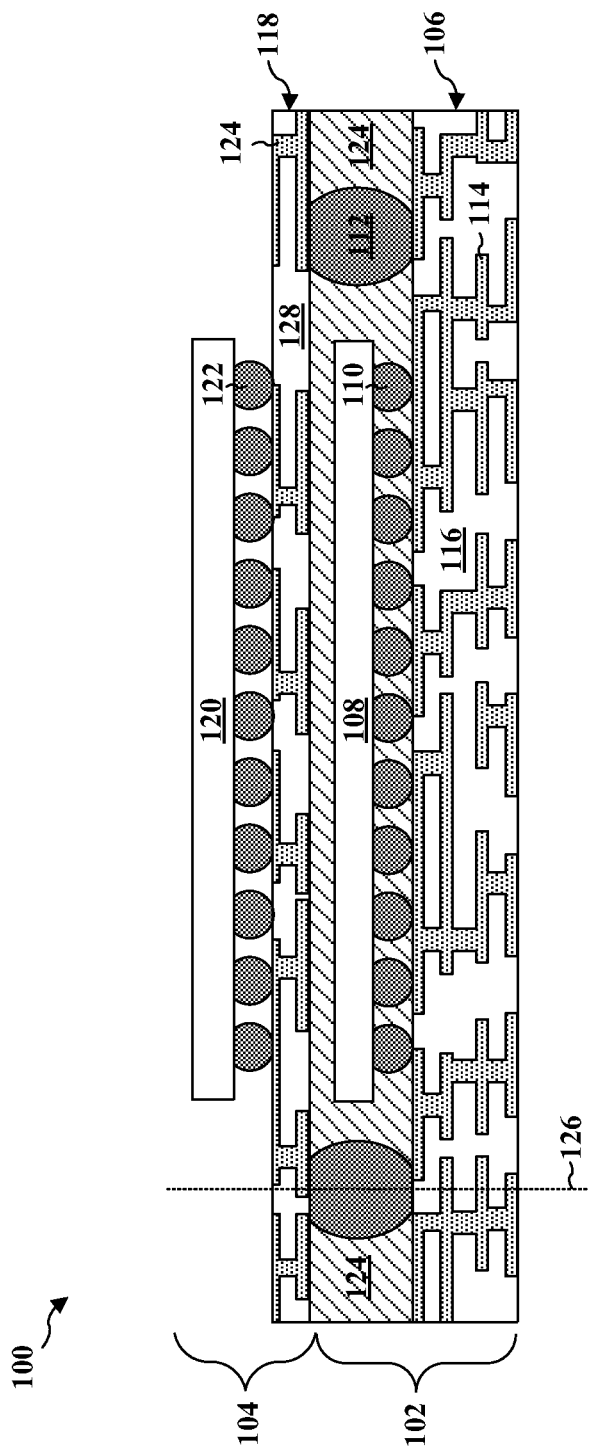


FIG. 1
PRIOR ART

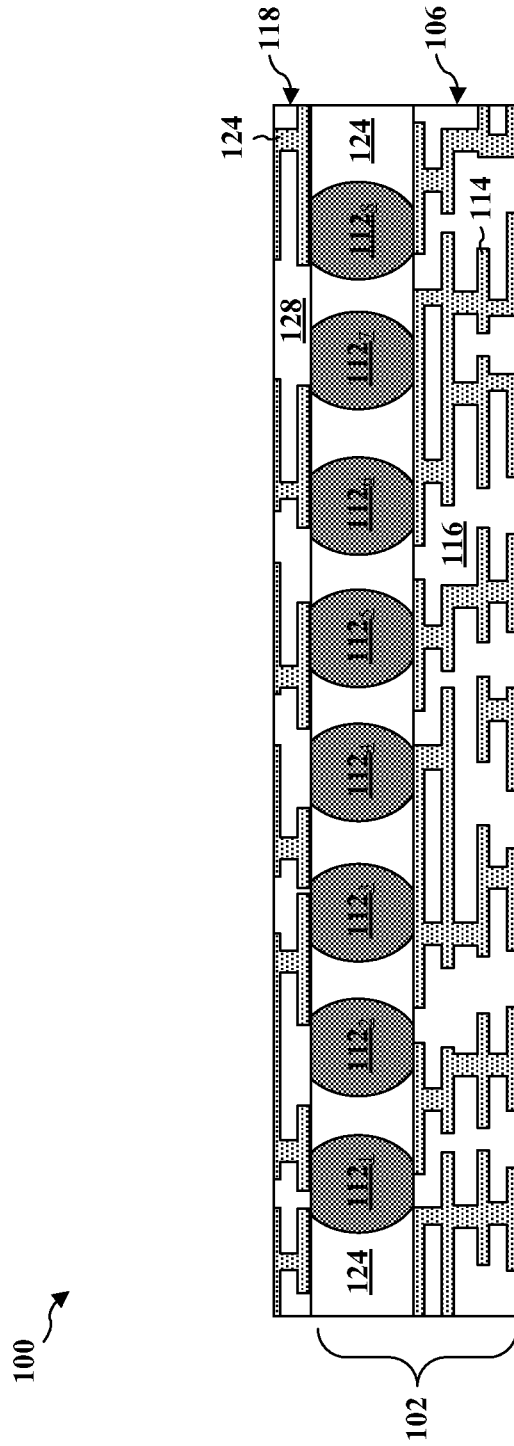


FIG. 2
PRIOR ART

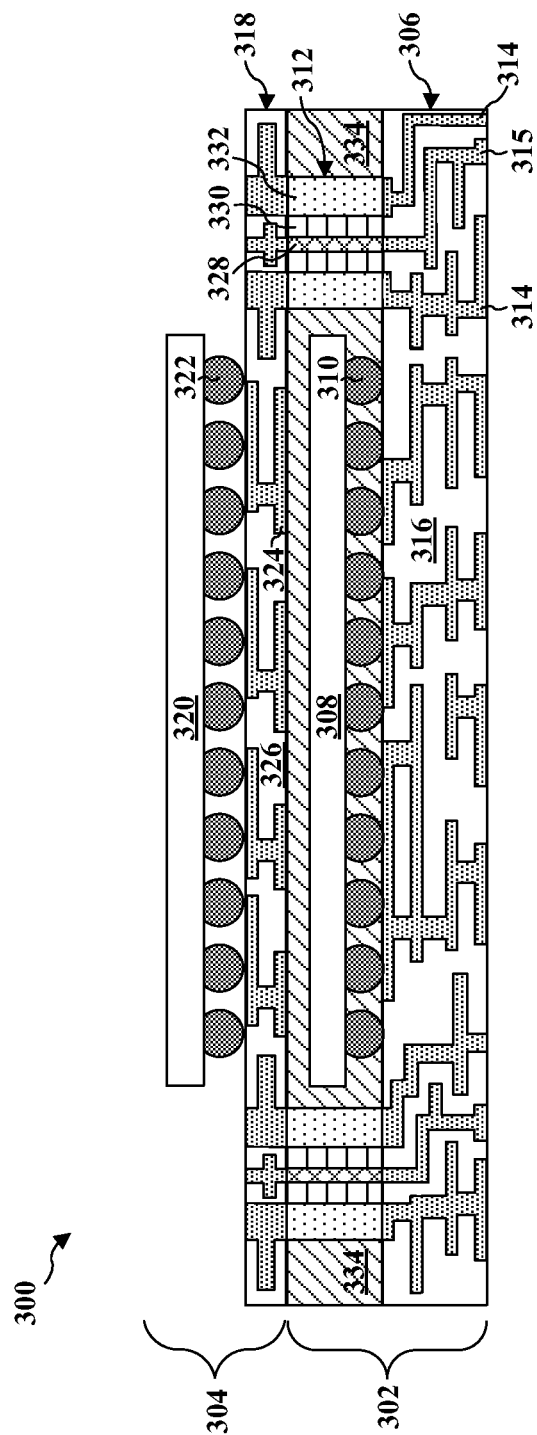


FIG. 3

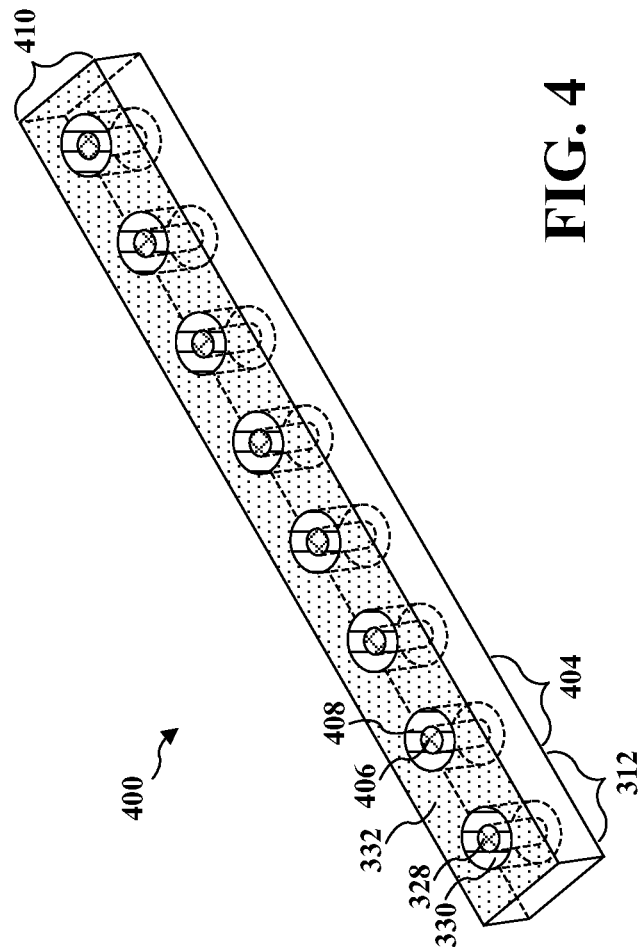


FIG. 4

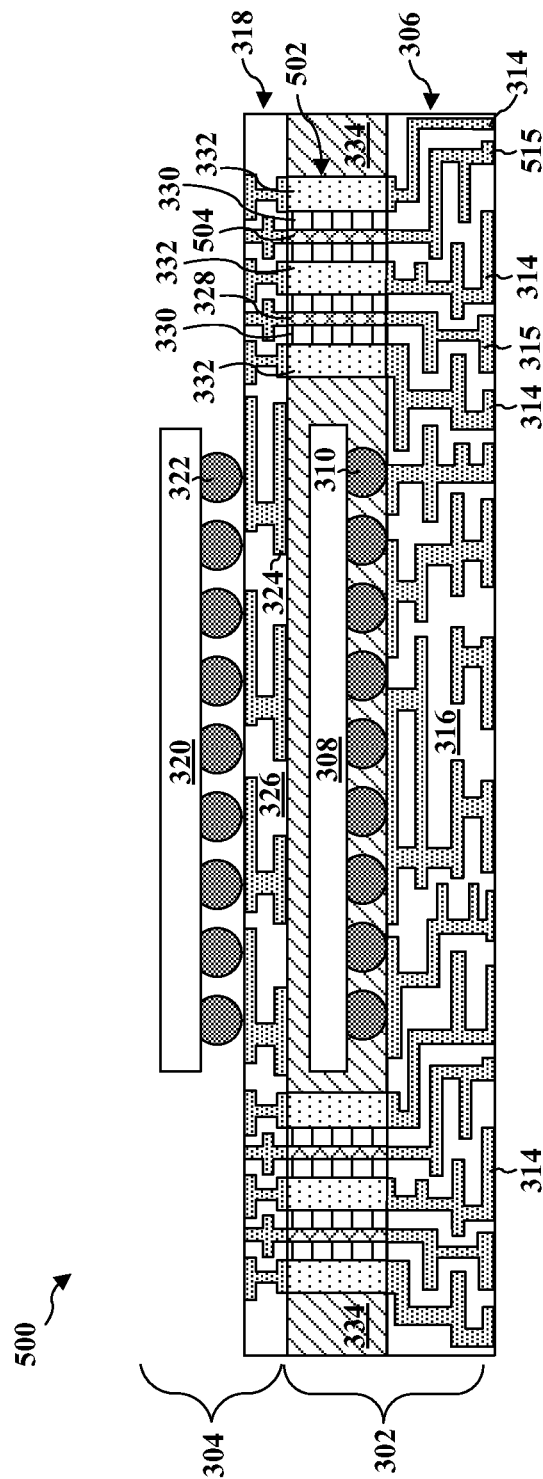
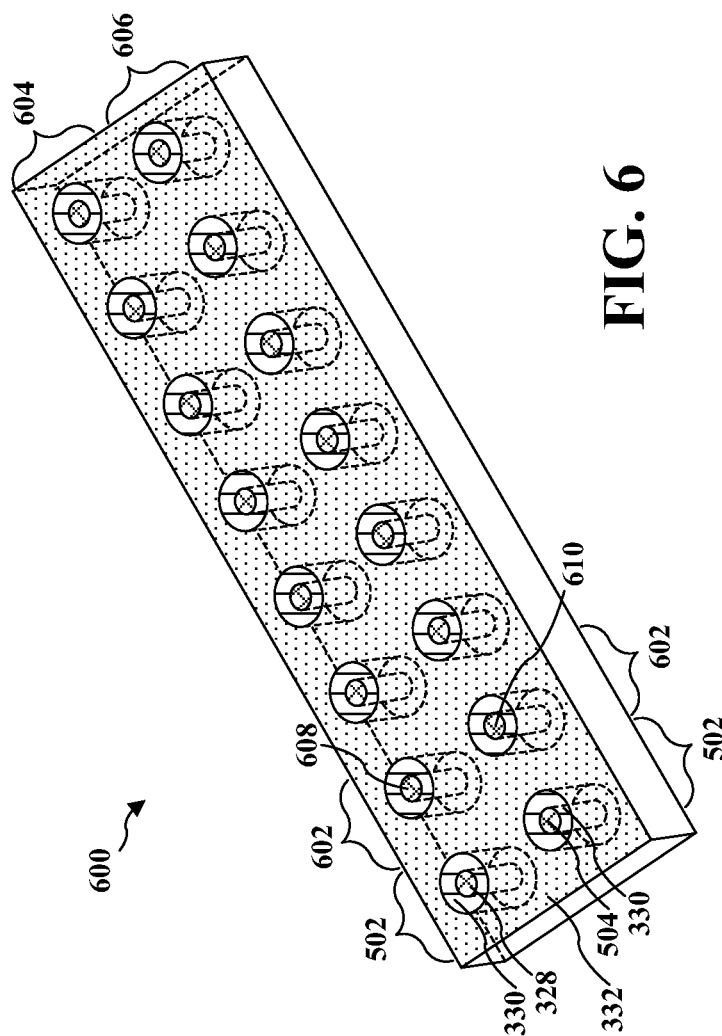


FIG. 5



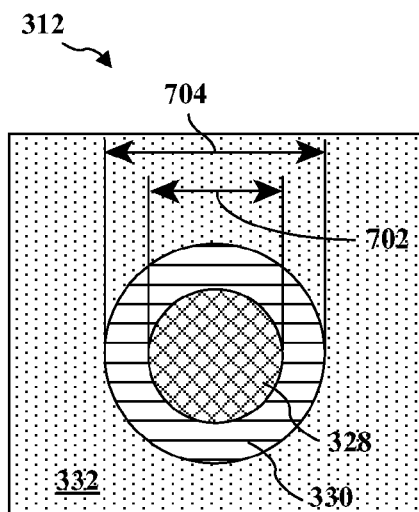


FIG. 7A

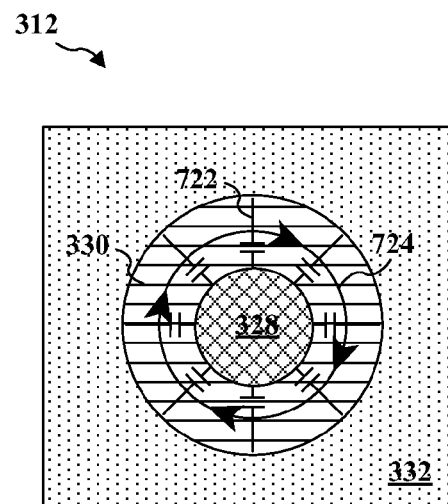


FIG. 7C

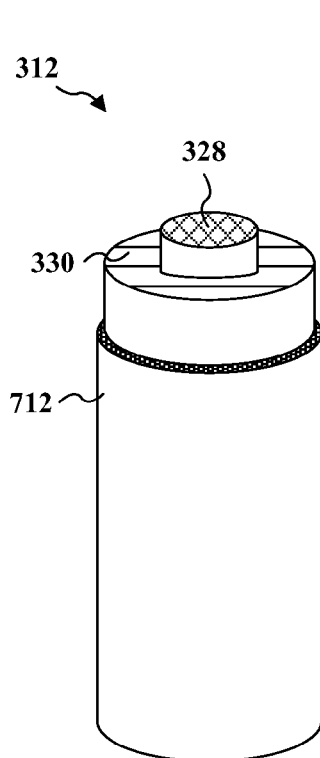


FIG. 7B

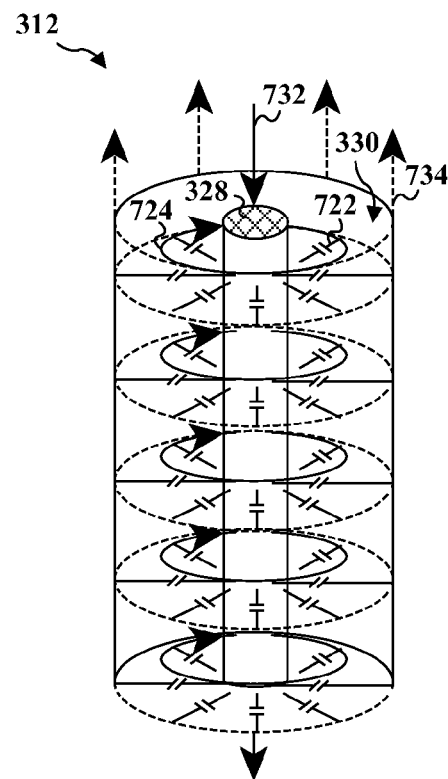


FIG. 7D

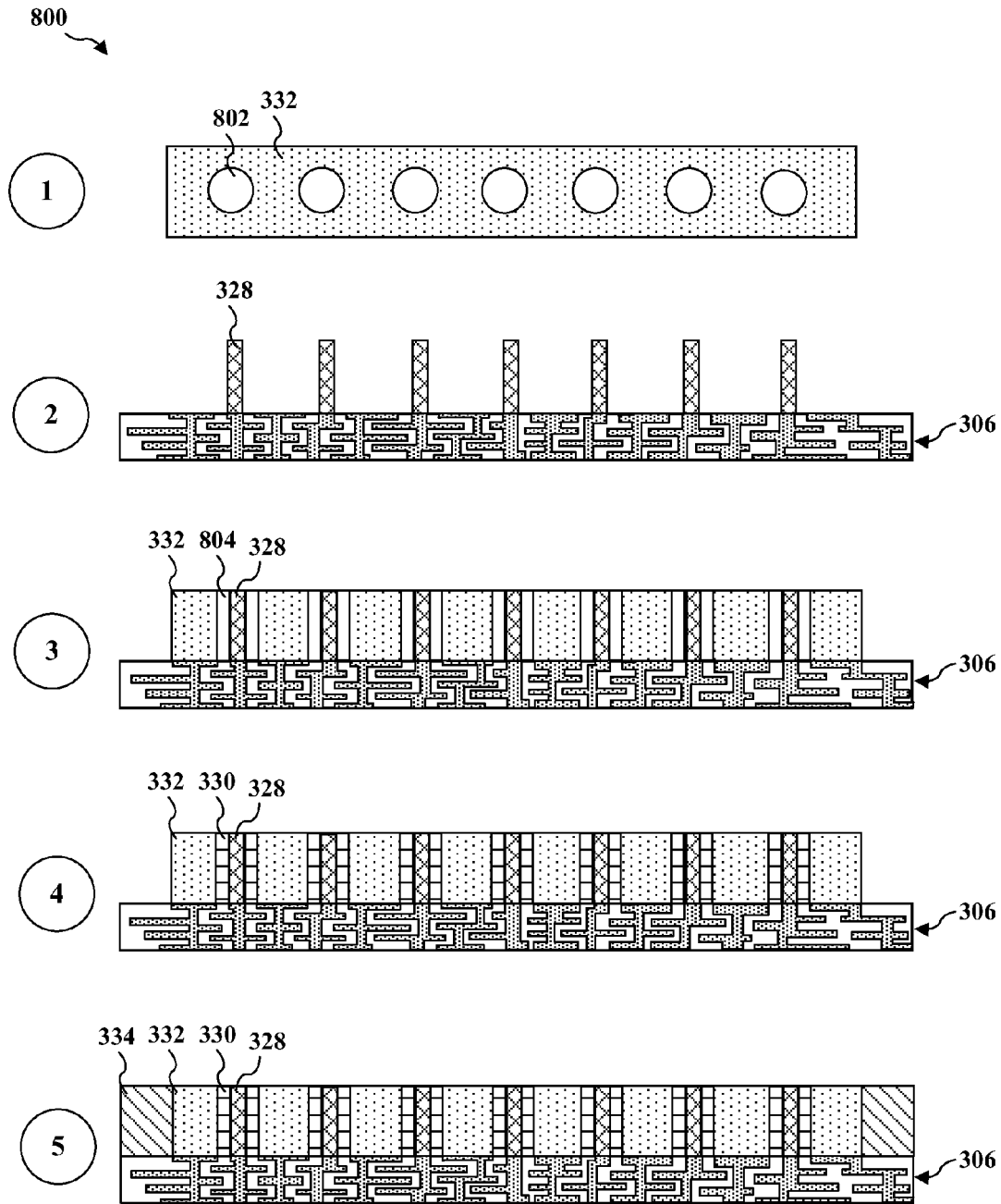


FIG. 8

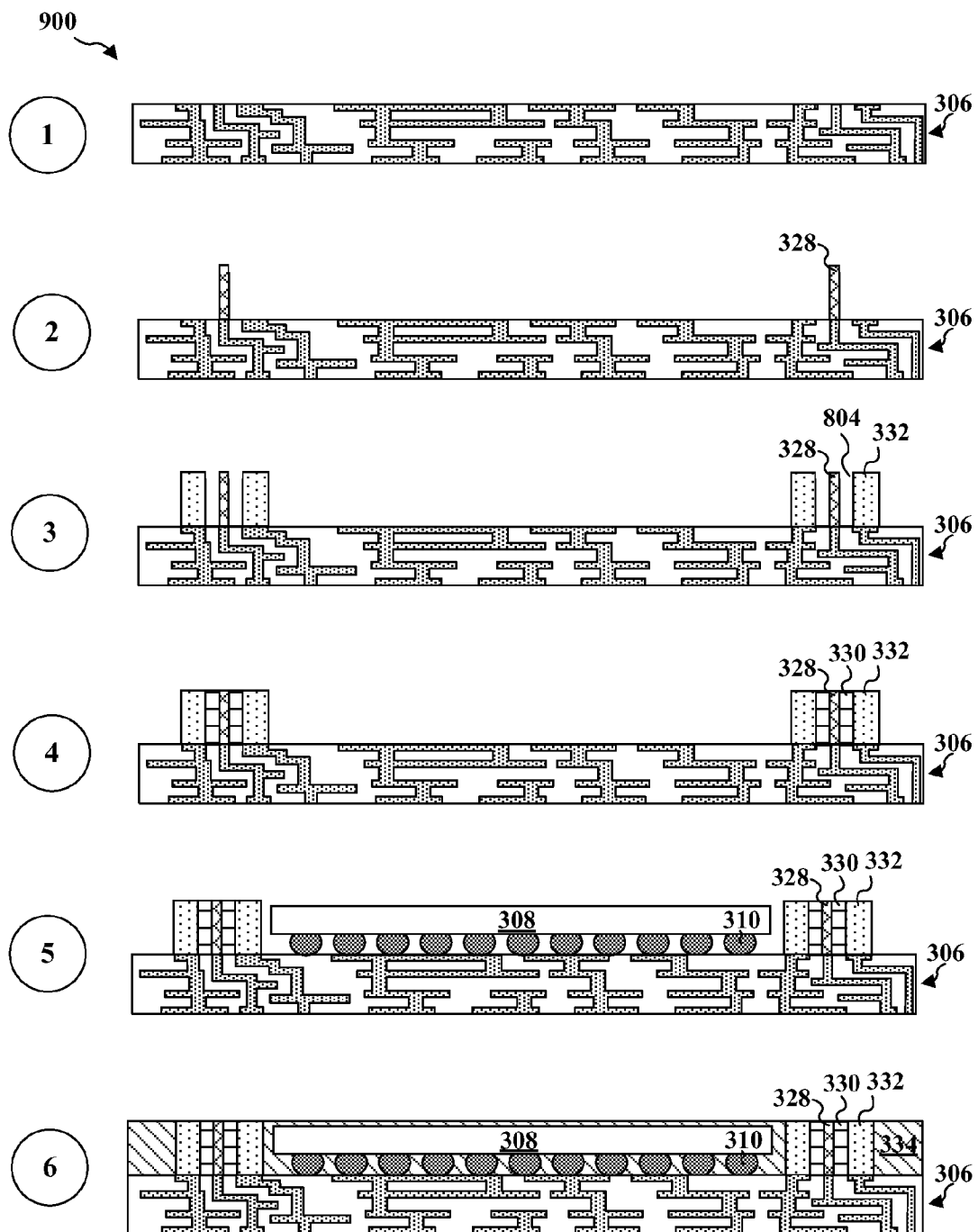


FIG. 9

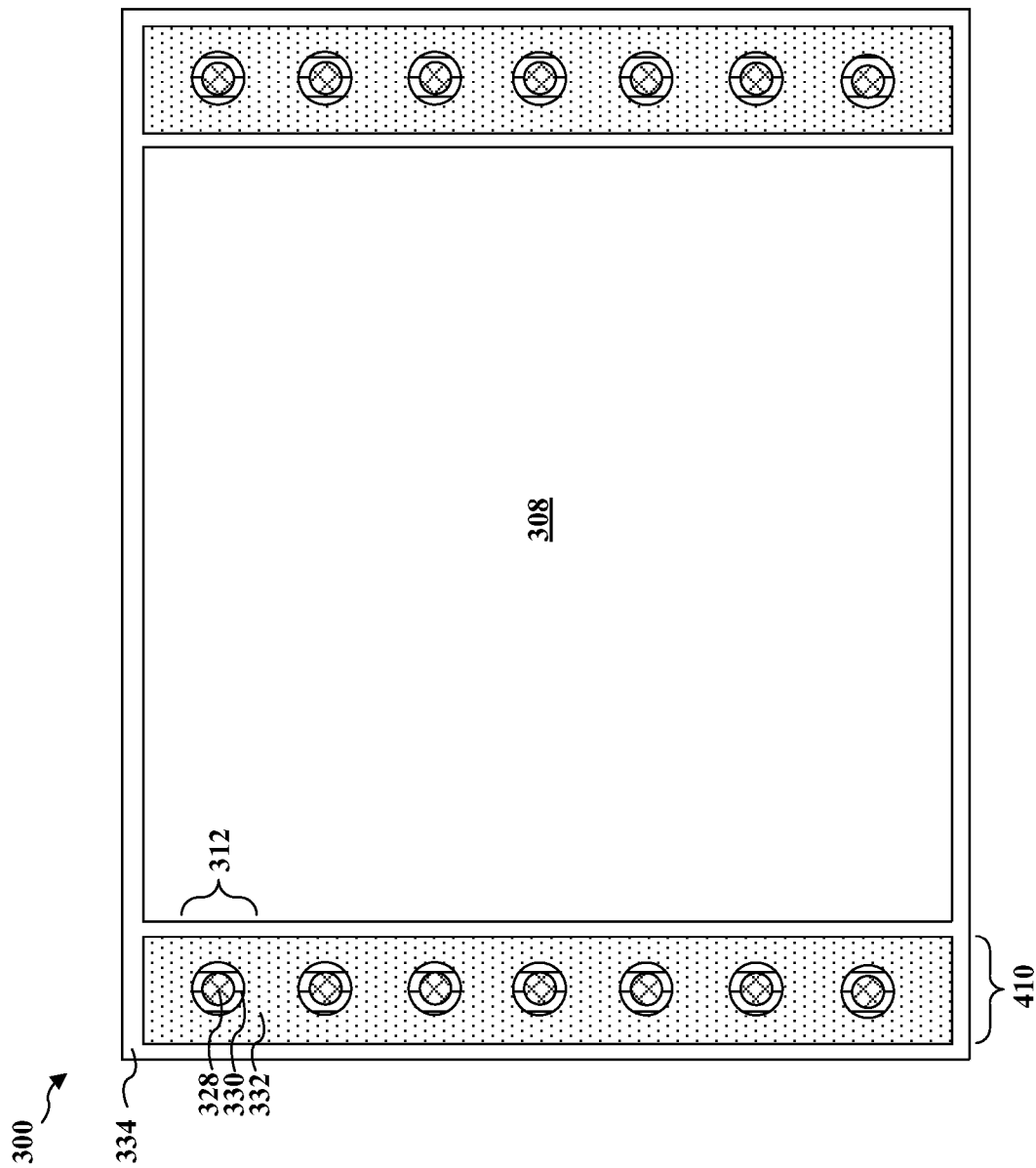


FIG. 10

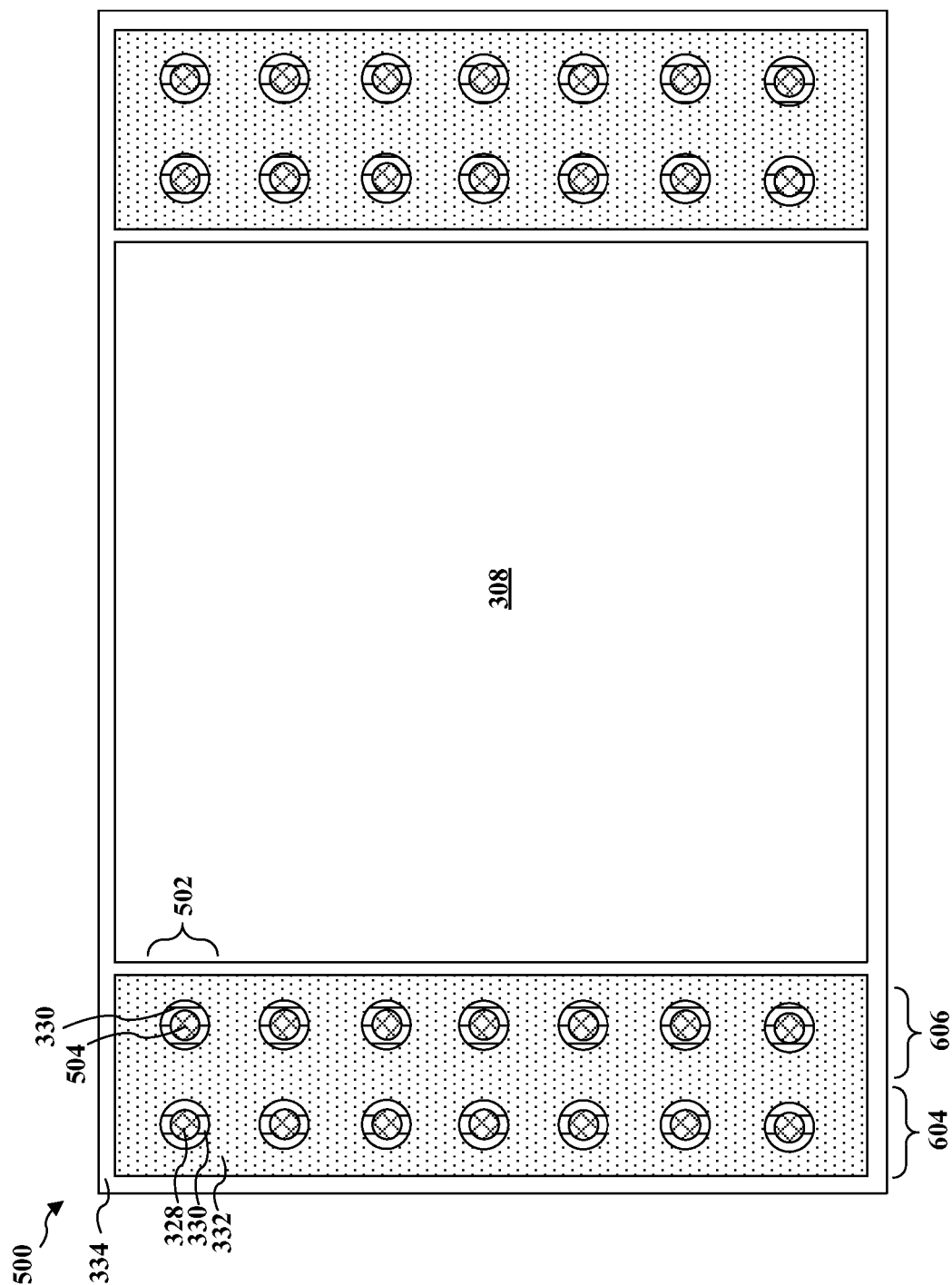


FIG. 11

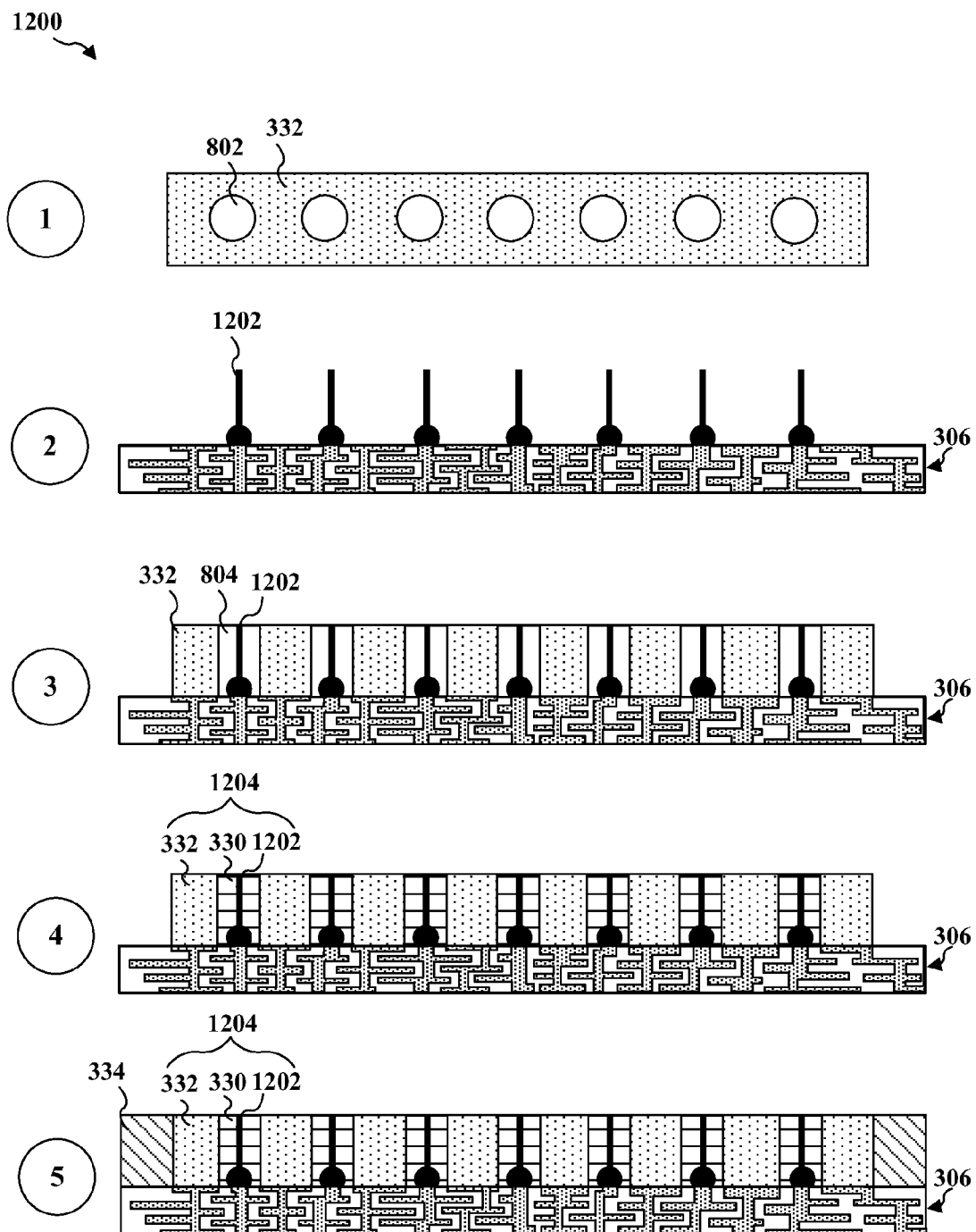


FIG. 12

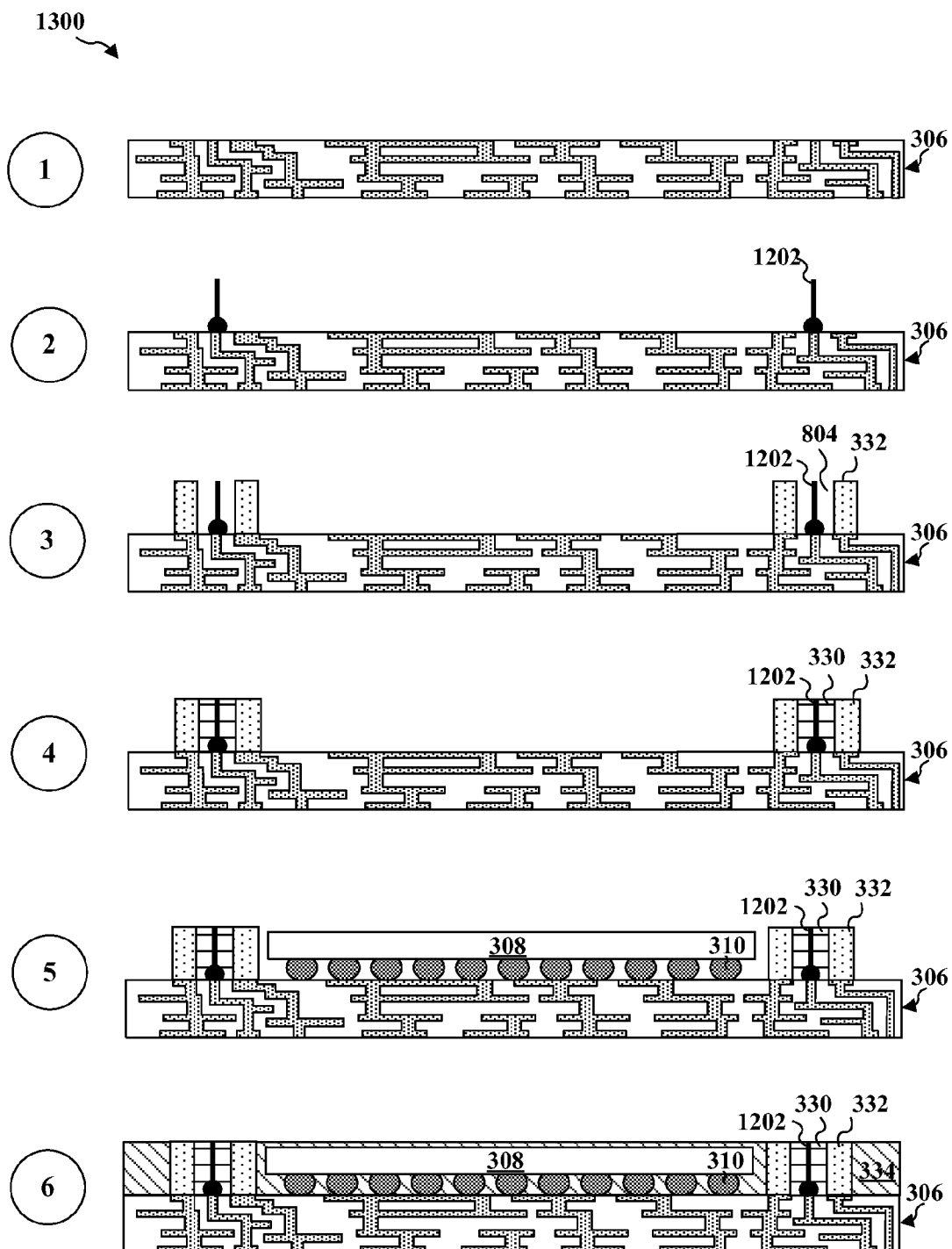


FIG. 13

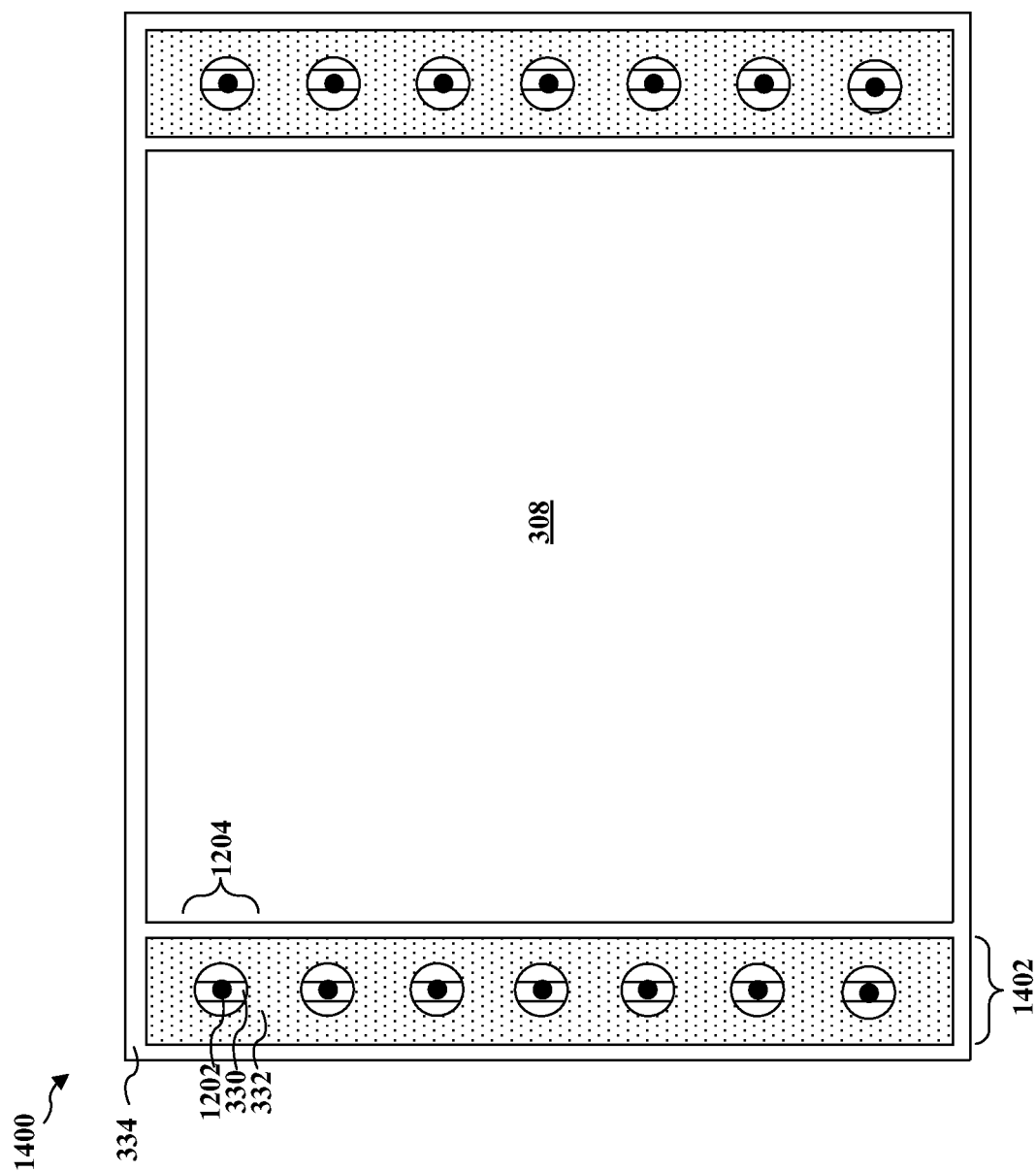


FIG. 14

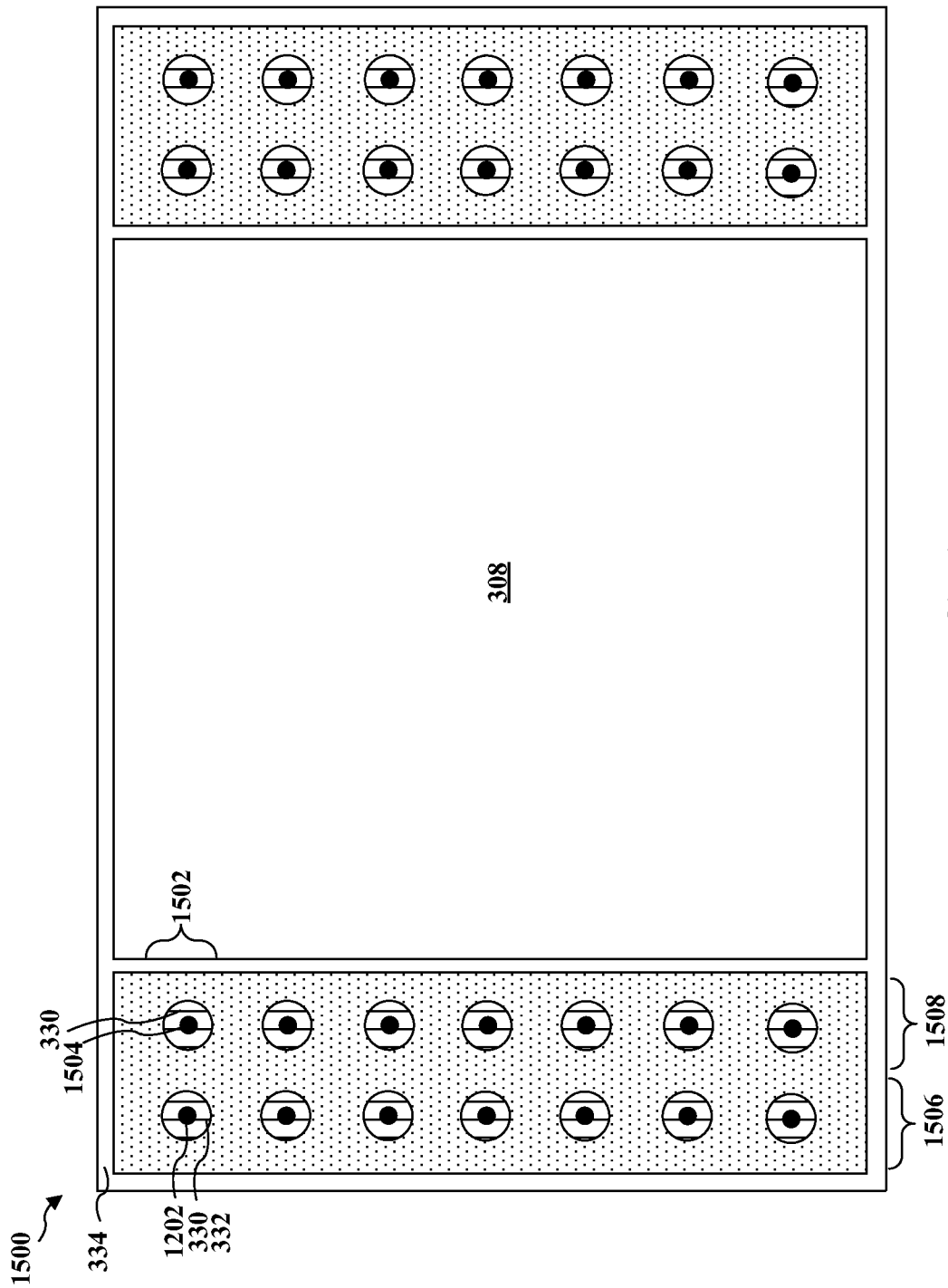
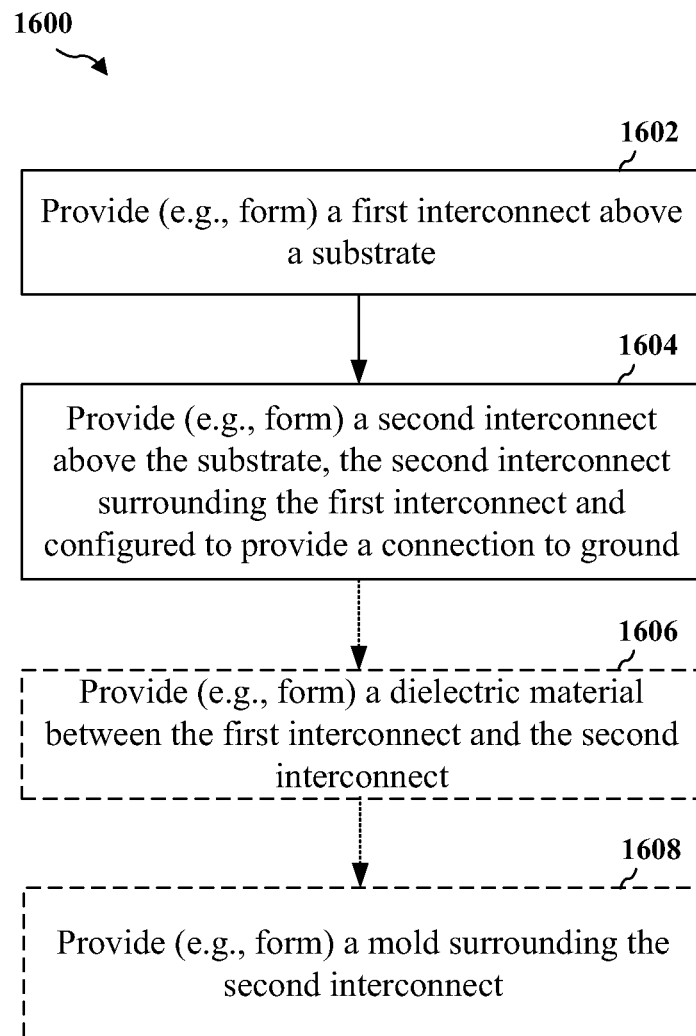


FIG. 15

**FIG. 16**

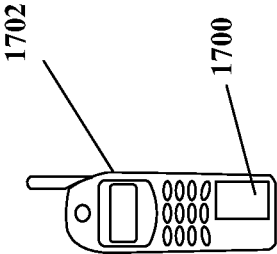
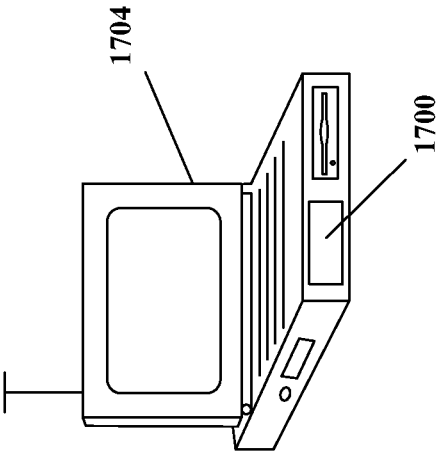
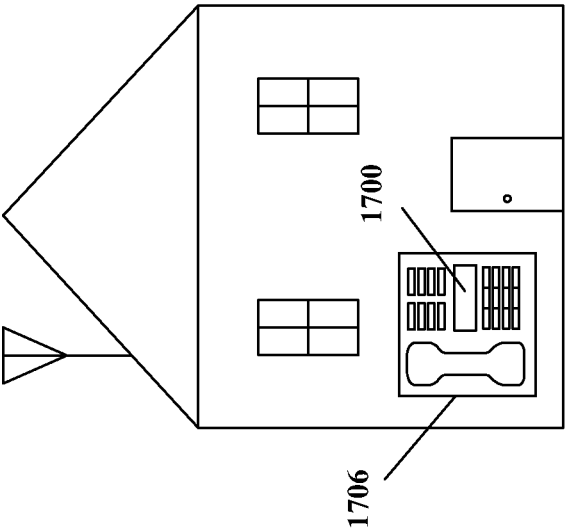


FIG. 17

1

INTEGRATED DEVICE COMPRISING COAXIAL INTERCONNECT

BACKGROUND

1. Field

Various features relate, generally, to an integrated device and, more specifically, to an integrated device including an interconnect surrounding another interconnect and providing a connection to ground.

2. Background

FIG. 1 illustrates a first cross-sectional view of a conventional integrated device **100** (e.g., a package-on-package (PoP) integrated device). The conventional integrated device **100** includes a first package **102** and a second package **104**. The first package **102** may include a first substrate **106**, a first die **108**, a first set of solder balls **110**, and a first set of interconnects **112**. The first set of solder balls **110** may electrically connect the first substrate **106** with the first die **108**. The first substrate **106** may include electrical interconnects **114** and dielectric layers **116**. The electrical interconnects **114** may traverse horizontally and/or vertically throughout the first substrate **106** to electrically connect various components contacting the first substrate **106**. For example, the electrical interconnects **114** may electrically connect one or more solder balls **110** with one or more interconnects **112**. The electrical interconnects **114** may be (at least) partially surrounded by the dielectric layers **116**.

The second package **104** may include a second substrate **118**, a second die **120**, and a second set of solder balls **122**. The second set of solder balls **122** may electrically connect the second substrate **118** with the second die **120**. The second substrate **118** may include electrical interconnects **124** and dielectric layers **128**. A mold **124** may exist in any portion of the space between the first substrate **106** and the second substrate **118**. For example, the mold **124** may encapsulate (at least) a portion of the first set of interconnects **112**, the first set of solder balls **110**, and/or the first die **108**.

The first set of interconnects **112** may electrically connect the first substrate **106** with the second substrate **118**. Each interconnect **112** may carry a power signal or a ground signal (e.g., a signal connected to ground).

FIG. 2 is a second cross-sectional view of the conventional integrated device **100**. The second cross-sectional view illustrated in FIG. 2 is along line **126** in FIG. 1. As illustrated in FIG. 2, a number (e.g., eight) interconnects (e.g., interconnects **112₁₋₈**) may electrically connect the first substrate **106** with the second substrate **118**. However, such designs have limitations. Any two interconnects carrying a power signal must be separated by at least one interconnect carrying a ground signal; otherwise, the power signals may interfere with each other, thereby causing unacceptable levels of insertion loss and/or isolation. Of the eight interconnects **112₁₋₈** shown in FIG. 2, four alternating interconnects (e.g., interconnects **112₁**, **112₃**, **112₅**, **112₇**) may carry a power signal while the other four alternating interconnects (e.g., interconnects **112₂**, **112₄**, **112₆**, **112₈**) may carry a ground signal. Such designs do not allow for a power signal to be transmitted through every interconnect **112** (e.g., all of the interconnects **112₁₋₈**). For example, if more than four power signal connections are needed between the first substrate **106** and the second substrate **118**, additional interconnects **112** must be added (beyond the eight interconnects **112₁₋₈** already illustrated in FIG. 2). Additional interconnects would undesirably expand the size of the overall conventional integrated device **100**. Therefore, existing designs may benefit from enhance-

2

ments that allow power signals to be conducted through every interconnect while maintaining acceptable levels of isolation and/or insertion loss.

SUMMARY

The following presents a simplified summary of one or more examples and/or aspects of the present disclosure, in order to provide a basic understanding of such aspects. This summary is not an extensive overview of all contemplated features of the disclosure, and is intended neither to identify key or critical elements of all aspects of the disclosure nor to delineate the scope of any or all aspects of the disclosure. Its sole purpose is to present some concepts of one or more aspects of the disclosure in a simplified form as a prelude to the more detailed description that is presented later.

Various features, apparatus and methods described herein provide an integrated device that includes a substrate, a first interconnect coupled to the substrate, and a second interconnect surrounding the first interconnect and configured to provide an electrical connection to ground.

A first example provides an integrated device that includes a substrate, a first interconnect coupled to the substrate, and a second interconnect surrounding the first interconnect and configured to provide an electrical connection to ground. According to some aspects, the second interconnect includes a plate. According to some aspects, the integrated device includes a dielectric material between the first interconnect and the second interconnect. According to some aspects, a mold surrounds the second interconnect. According to some aspects, the first interconnect is configured to conduct a power signal in a first direction. According to some aspects, the second interconnect is configured to conduct a grounding signal in a second direction. According to some aspects, the second direction is different from the first direction. According to some aspects, the integrated device includes one of at least an interposer, a package device, and/or a PoP device. In some aspects, the integrated device is incorporated into at least one of a music player, a video player, an entertainment unit, a navigation device, a communications device, a mobile device, a mobile phone, a smartphone, a personal digital assistant, a fixed location terminal, a tablet computer, and/or a laptop computer.

A second example provides an apparatus that includes a substrate, a first interconnect coupled to the substrate, and a second interconnect surrounding the first interconnect and configured to provide an electrical connection to ground. According to some aspects, the second interconnect includes a plate. According to some aspects, the apparatus includes a dielectric material between the first interconnect and the second interconnect. According to some aspects, a mold surrounds the second interconnect. According to some aspects, the first interconnect is configured to conduct a power signal in a first direction. According to some aspects, the second interconnect is configured to conduct a grounding signal in a second direction. According to some aspects, the second direction is different from the first direction. According to some aspects, the apparatus includes one of at least an interposer, a package device, and/or a PoP device. In some aspects, the apparatus is incorporated into at least one of a music player, a video player, an entertainment unit, a navigation device, a communications device, a mobile device, a mobile phone, a smartphone, a personal digital assistant, a fixed location terminal, a tablet computer, and/or a laptop computer.

A third example provides a method that includes providing a first interconnect above a substrate, and providing a second

3

interconnect above the substrate, wherein the second substrate surrounds the first substrate and is configured to provide an electrical connection to ground. According to some aspects, the second interconnect includes a plate. According to some aspects, the integrated device includes a dielectric material between the first interconnect and the second interconnect. According to some aspects, a mold surrounds the second interconnect. According to some aspects, the first interconnect is configured to conduct a power signal in a first direction. According to some aspects, the second interconnect is configured to conduct a grounding signal in a second direction. According to some aspects, the second direction is different from the first direction. According to some aspects, the integrated device includes one of at least an interposer, a package device, and/or a PoP device. In some aspects, the integrated device is incorporated into at least one of a music player, a video player, an entertainment unit, a navigation device, a communications device, a mobile device, a mobile phone, a smartphone, a personal digital assistant, a fixed location terminal, a tablet computer, and/or a laptop computer.

These and other examples and/or aspects of the disclosure will become more fully understood upon a review of the detailed description, which follows. Other aspects, features, and embodiments of the present disclosure will become apparent to those of ordinary skill in the art, upon reviewing the following description of specific, exemplary embodiments of the present disclosure in conjunction with the accompanying figures.

DRAWINGS

Various features, nature and advantages may become apparent from the detailed description set forth below when taken in conjunction with the drawings in which like reference characters identify correspondingly throughout.

FIG. 1 illustrates a first cross-sectional view of a conventional integrated device.

FIG. 2 illustrates a second cross-sectional view of the conventional integrated device.

FIG. 3 illustrates a cross-sectional view of a first exemplary integrated device.

FIG. 4 illustrates a side perspective view of exemplary coaxial connections in the first exemplary integrated device.

FIG. 5 illustrates a cross-sectional view of a second exemplary integrated device.

FIG. 6 illustrates a side perspective view of exemplary coaxial connections in the second exemplary integrated device.

FIGS. 7A-7D illustrate various aspects of an exemplary coaxial connection.

FIG. 8 illustrates a first exemplary sequence for providing/fabricating the exemplary coaxial connections in the first exemplary integrated device.

FIG. 9 illustrates an exemplary sequence for providing/fabricating the first exemplary integrated device.

FIG. 10 illustrates a top cross-sectional view of the first exemplary integrated device.

FIG. 11 illustrates a top cross-sectional view of the second exemplary integrated device.

FIG. 12 illustrates an exemplary sequence for providing/fabricating exemplary coaxial connections in a third exemplary integrated device.

FIG. 13 illustrates an exemplary sequence for providing/fabricating the third exemplary integrated device.

FIG. 14 illustrates a top cross-sectional view of the third exemplary integrated device.

4

FIG. 15 illustrates a top cross-sectional perspective view of a fourth exemplary integrated device.

FIG. 16 illustrates an exemplary flow diagram of a method for providing/fabricating an integrated device.

FIG. 17 illustrates various electronic devices that may integrate an integrated device, a semiconductor device, a die, an integrated circuit and/or printed circuit board (PCB) described herein.

DETAILED DESCRIPTION

In the following description, specific details are given to provide a thorough understanding of the various aspects of the disclosure. However, it will be understood by one of ordinary skill in the art that the aspects may be practiced without these specific details. For example, circuits may be shown in block diagrams in order to avoid obscuring the aspects in unnecessary detail. In other instances, well-known circuits, structures and techniques may not be shown in detail in order not to obscure the aspects of the disclosure.

Overview

Some novel features pertain to an integrated device (e.g., a package-on-package (PoP) integrated device) that includes a substrate, a first interconnect coupled to the substrate, and a second interconnect surrounding the first interconnect and configured to provide an electrical connection to ground. The second interconnect may include a plate. The integrated device may include a dielectric material between the first interconnect and the second interconnect. A mold may surround the second interconnect. The first interconnect may be configured to conduct a power signal in a first direction. The second interconnect may be configured to conduct a grounding signal in a second direction. The second direction may be different from the first direction. The integrated device may include one of at least an interposer, a package device, and/or a PoP device.

TERMS AND DEFINITIONS

An interconnect is an element or component that allows or facilitates an electrical connection between two points, elements and/or components. In some implementations, an interconnect may include a trace, a via, a pad, a pillar, a redistribution metal layer, and/or an under bump metallization (UBM) layer. In some implementations, an interconnect is an electrically conductive material that provides an electrical path for a signal (e.g., data signal, ground signal, power signal). An interconnect may include more than one element/component.

A netlist is defined as a set of interconnects, a set of active elements (e.g., transistor) and/or a set of passive elements (e.g., resistor, capacitor) that form and/or define the connectivity of a circuit in an integrated device.

First Exemplary Integrated Device

FIG. 3 illustrates an integrated device 300 (e.g., a PoP integrated device) that includes a first package 302 and a second package 304. The first package 302 may include a first substrate 306, a first die 308, a first set of solder balls 310, and at least one coaxial connection 312. The first set of solder balls 310 may electrically connect the first substrate 306 with the first die 308. The first substrate 306 may include various materials without deviating from the scope of the present disclosure. As non-limiting examples, the first substrate 306 may include silicon, glass, ceramic, a wafer, and/or various organic materials. The first substrate 306 may include electrical interconnects 314 and 315, and dielectric layers 316. The electrical interconnects 314 and/or 315 may include vari-

5

ous materials without deviating from the scope of the present disclosure. As a non-limiting example, the electrical interconnects **314** and/or **315** may include copper. The interconnects **314** and/or **315** may include one or more traces, vias and/or pads. The electrical interconnects **314** and/or **315** may traverse horizontally and/or vertically throughout the first substrate **306** to electrically connect various components contacting the first substrate **306**. For example, the electrical interconnects **314** and/or **315** may electrically connect one or more solder balls **310** and one or more coaxial connections **312**. The electrical interconnects **314** and/or **315** may be (at least) partially surrounded by the dielectric layers **316**. The dielectric layers **316** may include various materials without deviating from the scope of the present disclosure. As a non-limiting example, the dielectric layers **316** may include silicon nitride (SiN).

The second package **304** may include a second substrate **318**, a second die **320**, and a second set of solder balls **322**. The second set of solder balls **322** may electrically connect the second substrate **318** with the second die **320**. The second substrate **318** may include various materials without deviating from the scope of the present disclosure. As non-limiting examples, the second substrate **318** may include silicon, glass, ceramic, a wafer, and/or various organic materials. The second substrate **318** may include electrical interconnects **324** and dielectric layers **326**. The electrical interconnects **324** may include various materials without deviating from the scope of the present disclosure. As a non-limiting example, the electrical interconnects **324** may include Al. The electrical interconnects **324** may traverse horizontally and/or vertically throughout the second substrate **318** to electrically connect various components contacting the second substrate **318**. For example, the electrical interconnects **324** may electrically connect one or more solder balls **322** and one or more coaxial connections **312**. The electrical interconnects **324** may be (at least) partially surrounded by the dielectric layers **326**. The dielectric layers **326** may include various materials without deviating from the scope of the present disclosure. As a non-limiting example, the dielectric layers **326** may include SiN.

A mold **334** may exist in any portion of the space between the first substrate **306** and the second substrate **318**. For example, the mold **334** may (at least) partially surround the coaxial connections **312**, the first set of solder balls **310**, and/or the first die **308**.

The coaxial connection **312** (e.g., coaxial transmission line) may connect the first substrate **306** with the second substrate **318**. The coaxial connection **312** may include a first interconnect **328** (e.g., a signal interconnect configured to transmit a power signal), an insulation material **330**, and a second interconnect **332** (e.g., an interconnect providing an electrical connection to ground). The insulation material **330** may include various materials without deviating from the scope of the present disclosure. As a non-limiting example, the insulation material **330** may include SiN. In some implementations, the insulation material **330** may be an encapsulation layer (e.g., mold, epoxy). In some implementations, the insulation material **330** may be the same material as the mold **334**.

The insulation material **330** may surround (at least) a portion of the first interconnect **328**. The insulation material **330** may electrically insulate the first interconnect **328** from the second interconnect **332**, thereby preventing signals in the first interconnect **328** from shorting through the second interconnect **332**.

The first interconnect **328** may electrically connect the first substrate **306** with the second substrate **318**. For example, the

6

first interconnect **328** may electrically connect the electrical interconnects **314** of the first substrate **306** with the electrical interconnects **324** of the second substrate **318**. The first interconnect **328** may also be electrically coupled to the interconnect **315**. The first interconnect **328** may be configured to conduct a power signal in a first direction, such as from the first substrate **306** to the second substrate **318**.

The second interconnect **332** may be a plate. The plate may include metal (e.g., Al). The second interconnect **332** may be configured to provide an electrical connection to ground. The second interconnect **332** may surround (at least) a portion of the insulation material **330**. As such, the second interconnect **332** may surround (at least) a portion of the first interconnect **328**. The second interconnect **332** may be configured to provide an electrical path for a grounding signal (e.g., a signal destined to ground) in a second direction. The second direction may be different from the first direction (described supra). For example, the grounding signal may be conducted from the second substrate **318** to the first substrate **306**. The grounding signal may be conducted in other directions that will be readily apparent to one of ordinary skill in the art. The second interconnect **332** may be electrically coupled to the interconnect **314**.

In some implementations, the interconnect **314** and/or the second interconnect **332** are part of a first netlist for a power distribution network (PDN) of the integrated device. For example, the interconnect **314** and/or the second interconnect **332** may be part of a ground netlist for a PDN of the integrated device.

In some implementations, the interconnect **315** and/or the first interconnect **328** are part of a second netlist for a power distribution network (PDN) of the integrated device. For example, the interconnect **315** and/or the first interconnect **328** may be part of a power netlist or a data signal netlist for a PDN of the integrated device.

Although the cross-sectional view illustrated in FIG. 3 shows two coaxial connections **312** (e.g., a left-hand-side coaxial connection **312** and a right-hand-side coaxial connection **312**), the integrated device **300** may also include additional coaxial connections (e.g., one or more coaxial connections behind and/or in-front-of the right-hand-side coaxial connection **312** and/or the left-hand-side coaxial connection **312**), as illustrated in FIG. 4.

FIG. 4 illustrates an angled perspective view of exemplary coaxial connections **400** in the first exemplary integrated device **300**. In some implementations, the coaxial connections **400** is an interconnect means (e.g., coaxial interconnect means). The exemplary coaxial connections **400** may include a number (e.g., eight) of individual coaxial connections (e.g., coaxial connections **312**, **404**) in a row (e.g., row **410**). However, one of ordinary skill in the art will understand that the row **410** may include as few as one coaxial connection (e.g., only coaxial connection **312**) or as many as hundreds, thousands, or millions of coaxial connections (or more) without deviating from the scope of the present disclosure. As described in greater detail supra, each coaxial connection **312**, **404** may include a first interconnect **328**, **406** (e.g., a signal interconnect), an insulation material **330**, **408**, and a second interconnect **332** (e.g., a grounding interconnect). The second interconnect **332** may be a metal plate that is shared among one or more coaxial connections (e.g., coaxial connections **312**, **404** share the same second interconnect **332**). The second interconnect **332** surrounds the first interconnect **328** of coaxial connection **312** as well as the first interconnect **406** of coaxial connection **404**. As described in greater detail supra, the second interconnect **332** may be configured to provide an electrical connection or path to ground.

Each coaxial connection (e.g., coaxial connection **312**, **404**) may conduct both a power signal as well as a grounding signal (e.g., a signal destined to ground). As described supra with reference to FIGS. 1-2, existing integrated devices (e.g., conventional integrated device **100**) include connections (e.g., interconnects **112**, **112₁₋₈**) between substrates (e.g., substrates **106**, **118**) that can transmit only a power signal or a grounding signal. As such, existing integrated devices may require at least two connections (e.g., interconnect **112₁** and interconnect **112₂**) to transmit both a power signal as well as a grounding signal. However, the present disclosure provides various examples and aspects of a coaxial connection (e.g., coaxial connection **312**) that can transmit both a power signal as well as a grounding signal.

In some implementations, the first interconnect **328** and the interconnect **406** may be part of the same netlist or different netlist a power distribution network (PDN) of the integrated device.

In some implementations, at least one or more of the first interconnects (e.g., interconnects **328**, **406**) surrounded by the insulation material are inner interconnects of a coaxial interconnect/an interconnect means (e.g., coaxial interconnect means). In some implementations, the second interconnect **332** is an outer interconnect of a coaxial interconnect/an interconnect means (e.g., coaxial interconnect means). In some implementations, the one or more inner interconnects provide a first electrical path for a power signal, and the outer interconnect provide a second electrical path for a ground signal. In some implementations, the combination of at least one or more of the first interconnects (e.g., interconnects **328**, **406**), the insulation material, and/or the second interconnect **332** is configured to operate as a coaxial interconnect/an interconnect means (e.g., coaxial interconnect means).

Second Exemplary Integrated Device

FIG. 5 illustrates a cross-sectional view of a second exemplary integrated device **500**. The second exemplary integrated device **500** may include a coaxial connection **502**. The coaxial connection **502** may connect the first substrate **306** with the second substrate **318**. The substrate **306** may include interconnects **314**, **315** and **515**. The interconnects **314**, **315** and/or **515** may include one or more traces, vias and/or pads. The coaxial connection **502** may include two (or more) first interconnects **328**, **504** (e.g., signal interconnects configured to transmit a power signal), an insulation material **330**, and a second interconnect **332** (e.g., an interconnect providing an electrical connection to ground). The first interconnects **328**, **504** may electrically connect the first substrate **306** with the second substrate **318**. For example, the first interconnects **328**, **504** may respectively electrically connect the electrical interconnects **315** and **515** of the first substrate **306** with the electrical interconnects **324** of the second substrate **318**. The first interconnects **328**, **504** may be configured to conduct power signals in a first direction, such as from the first substrate **306** to the second substrate **318**.

The insulation material **330** may surround (at least) a portion of the first interconnects **328**, **504**. The insulation material **330** may electrically insulate the first interconnects **328**, **504** from the second interconnect **332**, thereby preventing signals in the first interconnects **328**, **504** from shorting through the second interconnect **332**. The insulation material **330** surrounding each first interconnects **328**, **504** may vary based on various design parameters. For example, the power and/or amperage of the signal in the first interconnects **328**, **504** may affect the type and/or amount of the insulation material **330** surrounding that the first interconnects **328**, **504**.

The second interconnect **332** may be configured to provide an electrical connection to ground. The second interconnect

332 may be a plate. The plate may include metal (e.g., Al). The second interconnect **332** may surround (at least) a portion of the insulation material **330**. As such, the second interconnect **332** may surround (at least) a portion of the first interconnects **328**, **504**. The second interconnect **332** may be configured to conduct a grounding signal (e.g., a signal destined to ground) in a second direction. The second direction may be different from the first direction (described supra). For example, the grounding signal may be conducted from the second substrate **318** to the first substrate **306**. The grounding signal may be conducted in other directions that will be readily apparent to one of ordinary skill in the art. The second interconnect **332** may be electrically coupled to the first interconnect **314**.

The mold **334** may exist in any portion of the space between the first substrate **306** and the second substrate **318**. For example, mold **334** may surround the coaxial connection **502**, the first set of solder balls **310**, and/or the first die **308**.

Each coaxial connection **502** may conduct two (or more) power signals (e.g., a power signal in the first interconnect **328** and another power signal in the first interconnect **504**) as well as a grounding signal (e.g., a signal in the second interconnect **332** and destined to ground). As described supra with reference to FIGS. 1-2, existing integrated devices (e.g., conventional integrated device **100** in FIGS. 1-2) include connections (e.g., interconnects **112**, **112₁₋₈** in FIGS. 1-2) between substrates (e.g., substrates **106**, **118** in FIGS. 1-2) that transmit only a power signal or a grounding signal. As such, existing integrated devices may require at least two connections (e.g., interconnect **112₁** and interconnect **112₂** in FIG. 2) to transmit both a power signal as well as a grounding signal. However, the present disclosure provides various examples of a coaxial connection (e.g., coaxial connection **502** in FIG. 5) that transmits two (or more) power signals as well as a grounding signal.

In some implementations, the interconnect **314** and/or the second interconnect **332** are part of a first netlist for a power distribution network (PDN) of the integrated device. For example, the interconnect **314** and/or the second interconnect **332** may be part of a ground netlist for a PDN of the integrated device.

In some implementations, the interconnect **315** and/or the first interconnect **328** are part of a second netlist for a power distribution network (PDN) of the integrated device. For example, the interconnect **315** and/or the first interconnect **328** may be part of a power netlist or a data signal netlist for a PDN of the integrated device.

In some implementations, the interconnect **515** and/or the interconnect **504** are part of a third netlist for a power distribution network (PDN) of the integrated device. For example, the interconnect **515** and/or the interconnect **504** may be part of a power netlist or a data signal netlist for a PDN of the integrated device.

In some implementations, the second netlist and the third netlist are part of the same netlist, while in some instances, the second netlist and the third netlist are different netlists.

Although the cross-sectional view illustrated in FIG. 5 shows two coaxial connections **502** (e.g., a left-hand-side coaxial connection **502** and a right-hand-side coaxial connection **502**), the integrated device **500** may also include additional coaxial connections (e.g., one or more coaxial connections behind and/or in-front-of the right-hand-side coaxial connection **502** and/or the left-hand-side coaxial connection **502**), as illustrated in FIG. 6.

FIG. 6 illustrates a side perspective view of exemplary coaxial connections **600** in the second exemplary integrated device **500**. The exemplary coaxial connections **600** may

include a number (e.g., eight) of individual coaxial connections (e.g., coaxial connections **502**, **602**) in rows (e.g., row **604** and row **606**). However, one of ordinary skill in the art will understand that each row (e.g., row **604** and/or row **606**) may include as few as one coaxial connection or as many as hundreds of coaxial connections (or more) without deviating from the scope of the present disclosure. As described in greater detail supra, each coaxial connection (e.g., coaxial connection **502**) may include two (or more) first interconnects **328**, **504** (e.g., a signal interconnect), an insulation material **330**, and a second interconnect **332** (e.g., a grounding interconnect). The second interconnect **332** may be a metal plate that is shared among one or more coaxial connections (e.g., coaxial connections **502**, **602** share the same second interconnect **332**). The second interconnect **332** may surround the first interconnects **328**, **504** of coaxial connection **502** as well as the first interconnects **608**, **610** of coaxial connection **602**. As described in greater detail supra, the second interconnect **332** may be configured to provide an electrical connection to ground.

In some implementations, at least one or more of the first interconnects (e.g., interconnects **328**, **406**, **608**, **610**) surrounded by the insulation material are inner interconnects of a coaxial interconnect/an interconnect means (e.g., coaxial interconnect means). In some implementations, the second interconnect **332** is an outer interconnect of a coaxial interconnect/an interconnect means (e.g., coaxial interconnect means). In some implementations, the one or more inner interconnects provide a first electrical path for a power signal, and the outer interconnect provide a second electrical path for a ground signal. In some implementations, the combination of at least one or more of the first interconnects (e.g., interconnects **328**, **406**), the insulation material, and/or the second interconnect **332** is configured to operate as a coaxial interconnect/an interconnect means (e.g., coaxial interconnect means).

Exemplary Aspects of a Coaxial Connection/Interconnects

Generally, FIGS. 7A-7D illustrate various aspects of a coaxial connection (e.g., coaxial connection **312**). Specifically, FIG. 7A shows a top cross-sectional view of the exemplary coaxial connection **312**. The first interconnect **328** may have a diameter **702**. For example, to meet a characteristic impedance value of approximately 50 ohms, the diameter **702** may have exemplary values of about 10 μm -100 μm . The first interconnect **328** and the insulation material **330**, collectively, may have a diameter **704**. An exemplary range of values for the diameter **704** is about 40 μm -400 μm . The insulation material **330** may have a thickness equal to the difference between the diameter **704** and the diameter **702**. An exemplary range of values for the thickness of the insulation material **330** (e.g., the difference between diameter **704** and the diameter **702**) is about 30 μm -300 μm (depending upon the dielectric constant of the insulation material **330**).

FIG. 7B shows a side perspective view of the exemplary coaxial connection **312**. As described in greater detail supra, the first exemplary coaxial connection **312** may include the first interconnect **328** and the insulation material **330**. In some configurations, the first exemplary coaxial connection **312** may also include a shield **712** that surrounds (at least) a portion of the insulation material **330**. The shield **712** may provide structural and/or mechanical support to the first interconnect **328** and/or the insulation material **330**. For example, the shield **712** may hold the insulation material **330** around the first interconnect **328**.

FIG. 7C shows a top view of various electrical aspects of the exemplary coaxial connection **312**. As described in greater detail supra, the insulation material **330** may be

located between two interconnects (e.g., the first interconnect **328** and the second interconnect **332**). Accordingly, the dielectric material **330** may have a capacitance **722**. Generally, capacitance is directly proportional to the surface area of the interconnect plates (e.g., the circumference of the first interconnect **328** and the circumference of the second interconnect **332**) and inversely proportional to the separation distance between the plates (e.g., the thickness of the dielectric material **330**, as described in greater detail supra). Also, the capacitance may be a function of the permittivity of the dielectric (e.g., the dielectric material **330**).

Because dielectric material **330** is located between two interconnects (e.g., the first interconnect **328** and the second interconnect **332**), a magnetic field **724** may exist between the two interconnects (e.g., between the first interconnect **328** and the second interconnect **332**). For example, if the current in the first interconnect **328** is traveling downwards (e.g., into the page), then the magnetic field **724** will be in a clockwise direction, as illustrated in FIG. 7C. The value of the magnetic field **724** may be determined using various methods known to one of ordinary skill in the art, such as Ampere's Law.

FIG. 7D shows a side view of various electrical aspects of the exemplary coaxial connection **312**. The first interconnect **328** may be configured to conduct an electrical signal (e.g., a power signal) in a first direction **732** (e.g., from top to bottom). The second interconnect **332** (see FIGS. 7A, 7C) may be configured to conduct an electrical signal (e.g., a grounding signal, such as a signal destined to ground) in a second direction **734** (e.g., from bottom to top). As illustrated in FIG. 7D, the second direction **734** may be different from the first direction **732**. As described in greater detail supra, the dielectric material **330** may have a capacitance **722**, and a magnetic field **724** may exist between the first interconnect **328** and the second interconnect **332** (see FIGS. 7A, 7C).

Exemplary Sequence for Providing/Fabricating Exemplary Coaxial Connections in the First Exemplary Integrated Device

FIG. 8 illustrates a first exemplary sequence **800** for providing/fabricating the exemplary coaxial connections **400** in the first exemplary integrated device **300**. The sequence **800** may include various stages. One of ordinary skill in the art will understand that the order of some of the stages illustrated in FIG. 8 may be changed without deviating from the scope of the present disclosure. In some implementations, several stages may be combined into a single stage. Detailed descriptions of various elements mentioned infra are provided supra and therefore will not be repeated.

Stage 1 of FIG. 8, illustrates a state after an interconnect (e.g., the second interconnect **332**) is provided. The second interconnect **332** may include one or more holes **802**.

Stage 2 illustrates a state after another interconnect (e.g., the first interconnect **328**) is provided above (e.g., on top of) a substrate (e.g., the substrate **306**) using a plating process. The plating process may include providing multiple layers of an electrically-conductive material on top of one another to produce a column or pillar-like shape extending upwards from the substrate **306**. Although this example refers to a plating process, one of ordinary skill in the art will understand that various techniques may be used to provide the first interconnect **328** above the substrate **306** without deviating from the scope of the present disclosure. In some implementations, a substrate is provided (e.g., formed) and a plating process is performed to form the interconnect **328**. The substrate that is provided may include one or more interconnects (e.g., traces, vias, pads).

Stage 3 illustrates a state after the second interconnect **332** is provided above (e.g., on top of) the substrate **306** such that

11

the first interconnects **328** are placed through/inside the holes **802** of the second interconnect **332**. Afterwards, at least some space **804** may exist between the first interconnect **328** and the second interconnect **332**.

Stage **4** illustrates a state after a dielectric material **330** is provided in the space **804** between the first interconnect **328** and the second interconnect **332**.

Stage **5** illustrates a state after a mold **334** (e.g., an encapsulation mold) is provided. The mold **334** may surround (at least) a portion of the second interconnect **332**. The mold **334** may provide structural/mechanical support to the first interconnect **328**, the insulation material **330**, and/or the second interconnect **332**. In some implementations, stage **4** may be optional and the mold **334** may be provided in the space **804**. Exemplary Sequence for Providing/Fabricating First and Second Exemplary Integrated Devices

FIG. **9** illustrates an exemplary sequence **900** for providing/fabricating the first exemplary integrated device **300**. The sequence **900** may include various stages. One of ordinary skill in the art will understand that the order of some of the stages illustrated in FIG. **9** may be changed without deviating from the scope of the present disclosure. Moreover, in some implementations, several stages may be represented into a single stage. Detailed descriptions of various elements mentioned infra are provided supra and therefore will not be repeated.

Stage **1** of FIG. **9** illustrates a state after a substrate (e.g., substrate **306**) is provided. The substrate includes dielectric layers and interconnects (e.g., traces, vias, pads).

Stage **2** illustrates a state after an interconnect (e.g., the first interconnect **328**) is provided above (e.g., on top of) the substrate **306** using a plating process, as described in greater detail supra. One of ordinary skill in the art will understand that various techniques may be used to provide the first interconnect **328** above the substrate **306** without deviating from the scope of the present disclosure.

Stage **3** illustrates a state after another interconnect (e.g., the second interconnect **332**) may be provided above (e.g., on top of) the substrate **306**. In some configurations, the second interconnect **332** is a metal plate with holes. At least some space **804** may exist between the first interconnect **328** and the second interconnect **332**.

Stage **4** illustrates a state after a dielectric material **330** is provided in the space **804** between the first interconnect **328** and the second interconnect **332**.

Stage **5** illustrates a state after a die **308** is provided (e.g., coupled) to the substrate. As shown in stage **5**, the die **308** is coupled to a set of solder balls **310**. The set of solder balls **310** are coupled to the interconnects of the substrate **306**. The die **308** may form an electrical connection with the set of solder balls **310** and interconnects of the substrate **306**. In some implementations, the die **308** may be provided and coupled to the substrate before the interconnects **328** and/or **332** are provided (e.g., formed) on the substrate.

Stage **6** illustrates a state after a mold **334** (e.g., an encapsulation mold) is provided. The mold **334** may surround (at least) a portion of the first interconnect **328**, the second interconnect **332**, the dielectric material **330**, the set of solder balls **310**, and/or the die **308**. The mold **334** may provide structural and/or mechanical support to the first interconnect **328**, the second interconnect **332**, the dielectric material **330**, the set of solder balls **310**, and/or the die **308**.

FIG. **10** illustrates a top cross-sectional view of the first exemplary integrated device **300**. The integrated device **300** may include one or more coaxial connections **312** in a row **410** on one or more sides of the die **308**. Each coaxial connection **312** may include a first interconnect **328**, a second

12

interconnect **332** surrounding the first interconnect **328**, and an insulation material **330** between the first interconnect **328** and the second interconnect **332**. The row **410** of coaxial connection(s) **312** may be surrounded by the mold **334**. Detailed descriptions of various elements mentioned supra have already been provided herein and therefore will not be repeated.

FIG. **11** illustrates a top perspective view of the second exemplary integrated device **500**. The integrated device **500** may include one or more sets of coaxial connections **502** in rows **604**, **606** on one or more sides of the die **308**. Each coaxial connection **502** may include first interconnects **328**, **504**, a second interconnect **332** surrounding the first interconnects **328**, **504**, and an insulation material **330** between the first interconnects **328**, **504** and the second interconnect **332**. The rows **604**, **606** of coaxial connection(s) **502** may be surrounded by the mold **334**. Detailed descriptions of various elements mentioned supra have already been provided herein and therefore will not be repeated.

Exemplary Sequence for Providing/Fabricating Exemplary Coaxial Connections in a Third Exemplary Integrated Device

FIG. **12** illustrates an exemplary sequence **1200** for providing/fabricating exemplary coaxial connections in a third exemplary integrated device (e.g., the integrated device **1400** illustrated in FIG. **14**). The sequence **1200** may include various stages. In some implementations, several stages may be represented as a single stage. One of ordinary skill in the art will understand that the order of some of the stages illustrated in FIG. **12** may be changed without deviating from the scope of the present disclosure. Detailed descriptions of various elements mentioned infra are provided supra and therefore will not be repeated.

Stage **1** of FIG. **12** illustrates a state after an interconnect (e.g., the second interconnect **332**) is provided. The second interconnect **332** may include one or more holes **802**.

Stage **2** illustrates a state after another interconnect (e.g., the first interconnect **1202**) is provided on a substrate (e.g., the substrate **306**). In some implementations, the interconnect **1202** is a wire bond. The first interconnect **1202** may be provided above (e.g., on top of) the substrate **306** using a wire-bonding process. Various types of wire-bonding may be implemented without deviating from the scope of the present disclosure. For example, "wire-bonding" may refer to ball bonding, wedge bonding, and/or compliant bonding. The wire-bonding process may produce a round end of the first interconnect **1202** (e.g., a solder ball-like portion at the bottom end of the first interconnect **1202**) and a vertical portion extending above the round end. Although this example refers to a wire-bonding process, one of ordinary skill in the art will understand that various other techniques may be used to provide the first interconnect **1202** above the substrate **306** without deviating from the scope of the present disclosure.

Stage **3** illustrates a state after the second interconnect **332** is provided above (e.g., on top of) the substrate **306** such that the first interconnects **1202** are placed through/inside the holes **802** of the second interconnect **332**. Afterwards, at least some space **804** may exist between the first interconnect **1202** and the second interconnect **332**.

Stage **4** illustrates a state after a dielectric material **330** is provided in the space **804** between the first interconnect **328** and the second interconnect **332**. The exemplary coaxial connection **1204** includes the first interconnect **1202**, the insulation material **330**, and the second interconnect **332**. In some implementations, the coaxial connection **1204** may include several first interconnects.

Stage **5** illustrates a state after a mold **334** (e.g., an encapsulation mold) is provided. The mold **334** may surround (at

13

least) a portion of the second interconnect **332**. The mold **334** may provide structural/mechanical support to the first interconnect **1202**, the insulation material **330**, and/or the second interconnect **332**.

In some implementations, at least one or more of the first interconnects (e.g., interconnects **1202**) surrounded by the insulation material **804** are inner interconnects of a coaxial interconnect/an interconnect means (e.g., coaxial interconnect means). In some implementations, the second interconnect **332** is an outer interconnect of a coaxial interconnect/an interconnect means (e.g., coaxial interconnect means). In some implementations, the one or more inner interconnects provide a first electrical path for a power signal, and the outer interconnect provide a second electrical path for a ground signal. In some implementations, the combination of at least one or more of the first interconnects (e.g., interconnects **1202**), the insulation material **804**, and/or the second interconnect **332** are configured to operate as a coaxial interconnect/an interconnect means (e.g., coaxial interconnect means).

Exemplary Sequence for Providing/Fabricating Third and Fourth Exemplary Integrated Devices

FIG. **13** illustrates an exemplary sequence **1300** for providing/fabricating the third exemplary integrated device (e.g., the integrated device **1400** illustrated in FIG. **14**). The sequence **1300** may include various stages. One of ordinary skill in the art will understand that the order of some of the stages illustrated in FIG. **13** may be changed without deviating from the scope of the present disclosure. Detailed descriptions of various elements mentioned infra are provided supra and therefore will not be repeated.

Stage **1** of FIG. **13** illustrates a state after a substrate (e.g., substrate **306**) is provided. The substrate may include dielectric layers and one or more interconnects (e.g., traces, vias, pads).

Stage **2** illustrates a state after an interconnect (e.g., the first interconnect **1202**) is provided above (e.g., on top of) the substrate **306** using a wire-bonding process, as described in greater detail supra. In some implementations, the interconnect **1202** is a wire bond. One of ordinary skill in the art will understand that various techniques may be used to provide the first interconnect **1202** above the substrate **306** without deviating from the scope of the present disclosure.

Stage **3** illustrates a state after another interconnect (e.g., the second interconnect **332**) is provided above (e.g., on top of) the substrate **306**. The second interconnect **332** may be a metal plate with holes. At least some space **804** may exist between the first interconnect **1202** and the second interconnect **332**.

Stage **4** illustrates a state after a dielectric material **330** is provided in the space **804** between the first interconnect **1202** and the second interconnect **332**.

Stage **5** illustrates a state after a die **308** is provided (e., coupled) to the substrate. As shown in stage **5**, the die **308** is coupled to a set of solder balls **310**. The set of solder balls **310** are coupled to the interconnects of the substrate **306**. The die **308** may form an electrical connection with the set of solder balls **310** and interconnects of the substrate **306**.

Stage **6** illustrates a state after a mold **334** (e.g., an encapsulation mold) may be provided. The mold **334** may surround (at least) a portion of the second interconnect **332**. The mold **334** may provide structural/mechanical support to the first interconnect **328**, the second interconnect **1202**, the dielectric material **330**, the set of solder balls **310**, and/or the die **308**.

In some implementations, at least one or more of the first interconnects (e.g., interconnects **1202**) surrounded by the insulation material **804** are inner interconnects of a coaxial

14

interconnect/an interconnect means (e.g., coaxial interconnect means). In some implementations, the second interconnect **332** is an outer interconnect of a coaxial interconnect/an interconnect means (e.g., coaxial interconnect means). In some implementations, the one or more inner interconnects provide a first electrical path for a power signal, and the outer interconnect provide a second electrical path for a ground signal. In some implementations, the combination of at least one or more of the first interconnects (e.g., interconnects **1202**), the insulation material **804**, and/or the second interconnect **332** are configured to operate as a coaxial interconnect/an interconnect means (e.g., coaxial interconnect means).

In some implementations, the interconnect **332** and/or an interconnect in the substrate **306** are part of a first netlist for a power distribution network (PDN) of the integrated device. For example, the interconnect **332** and/or an interconnect in the substrate **306** may be part of a ground netlist for a PDN of the integrated device.

In some implementations, the interconnect **1202** and/or another interconnect in the substrate **306** are part of a second netlist for a power distribution network (PDN) of the integrated device. For example, the interconnect **1202** and/or another interconnect in the substrate **306** may be part of a power netlist or data signal netlist for a PDN of the integrated device.

In some implementations, at least some of the interconnects **1202** (e.g., wire bond) may be part of the same netlist of a PDN. In some implementations, at least some of the interconnects **1202** (e.g., wire bond) may be part of the same netlist of a PDN.

FIG. **14** illustrates a top cross-sectional view of the third exemplary integrated device **1400**. The third exemplary integrated device **1400** may include one or more coaxial connections **1204** in a row **1402** on one or more sides of the die **308**. Each coaxial connection **1204** may include a first interconnect **1202**, a second interconnect **332** surrounding the first interconnect **1202**, and an insulation material **330** between the first interconnect **1202** and the second interconnect **332**. The row **1402** of coaxial connection(s) **1204** may be surrounded by the mold **334**. Detailed descriptions of various elements mentioned supra have already been provided herein and therefore will not be repeated.

FIG. **15** illustrates a top cross-sectional view of a fourth exemplary integrated device **1500**. The fourth exemplary integrated device **1500** may include one or more sets of coaxial connections **1502** in rows **1506**, **1508** on one or more sides of the die **308**. Each coaxial connection **1502** may include first interconnects **1202**, **1504**, a second interconnect **332** surrounding the first interconnects **1202**, **1504**, and an insulation material **330** between the first interconnects **1202**, **1504** and the second interconnect **332**. The rows **1506**, **1508** of coaxial connection(s) **1502** may be surrounded by the mold **334**. Detailed descriptions of various elements mentioned supra have already been provided herein and therefore will not be repeated.

Exemplary Methods for Providing/Fabricating an Integrated Device Including a Coaxial Connection

FIG. **16** illustrates an exemplary flow diagram of exemplary methods for providing/fabricating an integrated device including a coaxial connection. The exemplary methods may provide/fabricate any one or more of the integrated devices illustrated supra. One of ordinary skill in the art will understand that the order of some of the blocks illustrated in FIG. **16** may be changed without deviating from the scope of the present disclosure. Also, one of ordinary skill in the art will also understand that any one or more of the blocks illustrated

15

in FIG. 16 may be combined without deviating from the scope of the present disclosure. Optional blocks are illustrated in dashed lines. Detailed descriptions of various elements mentioned infra are provided supra and therefore will not be repeated. The exemplary methods described herein may be performed by an apparatus (e.g., a manufacturing device).

At block 1602, the apparatus may provide (e.g., form) a first interconnect above (e.g., on top of) a substrate. For example, referring to stage 2 in FIG. 8, the first interconnect 328 may be provided (e.g., formed) on the substrate 306. As described in greater detail supra, the first interconnect 328 may be provided (e.g., formed) on the substrate 306 using various techniques. An example of such a technique is a plating process, as described in greater detail supra. Accordingly, the providing of the first interconnect above the substrate may include plating the first interconnect 328 on the substrate 306 (see e.g., FIG. 8). Another example of such a technique is a wire-bonding process, as described in greater detail supra. Accordingly, the providing of the first interconnect above the substrate may include wire-bonding the first interconnect 1202 on the substrate 306 (see e.g., FIG. 12). Alternative techniques for providing a first interconnect on a substrate are known to one of ordinary skill in the art and therefore are within the scope of the present disclosure.

At block 1604, the apparatus may provide (e.g., form) a second interconnect above the substrate. The second substrate may surround the first interconnect and be configured to provide a connection to ground. For example, referring to stage 3 in FIG. 8, the apparatus may provide (e.g., form) the second interconnect 332 on the substrate 306. In some configurations, the second interconnect 332 may be a metal plate including holes 802. The first interconnects 328 may be provided (e.g., positioned) inside/through the holes 802 of the second interconnect 332. As illustrated in FIGS. 7A, 7C, the second interconnect 332 surrounds the first interconnect 328. The second interconnect 332 may be configured to provide an electrical connection to ground.

At block 1606, the apparatus may provide (e.g., form) a dielectric material between the first interconnect and the second interconnect. For example, referring (again) to stage 3 in FIG. 8, at least some space 804 may exist between the first interconnect 328 and the second interconnect 332. The dielectric material 330 may be provided (e.g., formed) into the space 804 between the first interconnect 328 and the second interconnect 332, as illustrated in stage 4 in FIG. 8.

At block 1608, the apparatus may provide (e.g., form) an encapsulation mold surrounding the second interconnect. For example, referring to stage 5 in FIG. 8, the mold 334 may be provided (e.g., formed) surrounding the second interconnect 332. The mold 334 may provide mechanical and/or structural support to the first interconnect 328, the second interconnect 332 surrounding the first interconnect 328, and/or the insulation material 330 between the first interconnect 328 and the second interconnect 332.

Exemplary Electronic Devices

FIG. 17 illustrates various electronic devices that may be integrated with any of the aforementioned integrated device, semiconductor device, integrated circuit, die, interposer and/or package. For example, a mobile telephone 1702, a laptop computer 1704, and a fixed location terminal 1706 may include an integrated device 1700 described herein. The integrated device 1700 may be, for example, any of the integrated circuits, dies, interposer, or packages described herein. The devices 1702, 1704, 1706 illustrated in FIG. 17 are merely exemplary. Other electronic devices may also feature the integrated device 1700 including, but not limited to, mobile devices, hand-held personal communication systems (PCS)

16

units, portable data units such as personal digital assistants, GPS enabled devices, navigation devices, set top boxes, music players, video players, entertainment units, fixed location data units such as meter reading equipment, communications devices, smartphones, tablet computers or any other device that stores or retrieves data or computer instructions, or any combination thereof

One or more of the components, steps, features, and/or functions illustrated in FIGS. 3, 4, 5, 6, 7A, 7B, 7C, 7D, 8, 9, 10, 11, 12, 13, 14, 15 and/or 16 may be rearranged and/or combined into a single component, step, feature or function or embodied in several components, steps, or functions. Additional elements, components, steps, and/or functions may also be added without departing from the disclosure. FIGS. 3, 4, 5, 6, 7A, 7B, 7C, 7D, 8, 9, 10, 11, 12, 13, 14, 15 and/or 16 and its corresponding description in the present disclosure are not limited to dies and/or (integrated circuits) IC. In some implementations, FIGS. 3, 4, 5, 6, 7A, 7B, 7C, 7D, 8, 9, 10, 11, 12, 13, 14, 15 and/or 16 and its corresponding description may be used to manufacture, create, provide, and/or produce integrated devices. In some implementations, an integrated device may include a die package, an IC, a wafer, a semiconductor device, and/or an interposer.

The word “exemplary” is used herein to mean “serving as an example, instance, or illustration.” Any implementation or aspect described herein as “exemplary” is not necessarily to be construed as preferred or advantageous over other aspects of the disclosure. Likewise, the term “aspects” does not require that all aspects of the disclosure include the discussed feature, advantage or mode of operation. The term “coupled” is used herein to refer to the direct or indirect coupling between two objects. For example, if object A physically touches object B, and object B touches object C, then objects A and C may still be considered coupled to one another—even if they do not directly physically touch each other.

Also, it is noted that the embodiments may be described as a process that is depicted as a flowchart, a flow diagram, a structure diagram, or a block diagram. Although a flowchart may describe the operations as a sequential process, many of the operations can be performed in parallel or concurrently. In addition, the order of the operations may be re-arranged. A process is terminated when its operations are completed.

The various features of the disclosure described herein can be implemented in different systems without departing from the disclosure. It should be noted that the foregoing aspects of the disclosure are merely examples and are not to be construed as limiting the disclosure. The description of the aspects of the present disclosure is intended to be illustrative, and not to limit the scope of the claims. As such, the present teachings can be readily applied to other types of apparatuses and many alternatives, modifications, and variations will be apparent to those skilled in the art.

What is claimed is:

1. An integrated device comprising:

- a first substrate with a first electrical interconnect;
- a second substrate with a second electrical interconnect;
- an inner interconnect configured to electrically couple to the first electrical interconnect of the first substrate and configured to electrically couple to the second electrical interconnect of the second substrate; and
- an outer interconnect surrounding the outer interconnect, the outer interconnect configured to provide an electrical connection to ground.

2. The integrated device of claim 1, wherein the outer interconnect comprises a plate.

17

3. The integrated device of claim 1, further comprising a dielectric material between the inner interconnect and the outer interconnect.

4. The integrated device of claim 1, further comprising a mold surrounding the outer interconnect.

5. The integrated device of claim 1, wherein the inner interconnect is configured to provide an electrical path for a power signal in a first direction.

6. The integrated device of claim 5, wherein the outer interconnect is configured to provide an electrical path for a grounding signal in a second direction.

7. The integrated device of claim 1, wherein the inner interconnect is one of at least a plated interconnect and/or wire bond.

8. The integrated device of claim 1, wherein the integrated device comprises one of at least an interposer, a package device, and/or a package-on-package (PoP) device.

9. The integrated device of claim 1, wherein the integrated device is incorporated into at least one of a music player, a video player, an entertainment unit, a navigation device, a communications device, a mobile device, a mobile phone, a smartphone, a personal digital assistant, a fixed location terminal, a tablet computer, and/or a laptop computer.

10. An apparatus comprising:

a first substrate with a first electrical interconnect;
a second substrate with a second electrical interconnect;
an inner interconnect means configured to electrically couple to the first electrical interconnect of the first substrate and configured to electrically couple to the second electrical interconnect of the second substrate; and

an outer interconnect means coupled to one or more of the first substrate and the second substrate, the outer interconnect means configured to provide an electrical connection to ground.

11. The apparatus of claim 10, wherein the outer interconnect means surrounds the inner interconnect means, and wherein the outer interconnect means comprises a plate.

12. The apparatus of claim 11, further comprising a dielectric material between the inner interconnect means and the outer interconnect means.

13. The apparatus of claim 10, further comprising a mold surrounding the outer interconnect means.

14. The apparatus of claim 11, wherein the inner interconnect means is configured to provide an electrical path for a power signal in a first direction.

15. The apparatus of claim 14, wherein the outer interconnect means is configured to provide an electrical path for a grounding signal in a second direction.

16. The apparatus of claim 11, wherein inner interconnect means is one of at least a plated interconnect and/or wire bond.

18

17. The apparatus of claim 10, wherein the apparatus comprises one of at least an interposer, a package device, and/or a package-on-package (PoP) device.

18. The apparatus of claim 10, wherein the apparatus is incorporated into at least one of a music player, a video player, an entertainment unit, a navigation device, a communications device, a mobile device, a mobile phone, a smartphone, a personal digital assistant, a fixed location terminal, a tablet computer, and/or a laptop computer.

19. A method of fabricating an integrated device, the method comprising:

forming a first substrate with a first electrical interconnect;
forming a second substrate with a second electrical interconnect;

forming an inner interconnect electrically coupling the inner interconnect to the first electrical interconnect of the first substrate and electrically coupling the inner interconnect to the second electrical interconnect of the second substrate; and

providing an outer interconnect, the outer interconnect surrounding the inner interconnect and configured to provide an electrical connection to ground.

20. The method of claim 19, wherein the forming the inner interconnect above the first substrate comprises plating the inner interconnect on the first substrate.

21. The method of claim 19, wherein the forming the inner interconnect above the first substrate comprises wire-bonding the inner interconnect on the first substrate.

22. The method of claim 19, wherein the outer interconnect comprises a plate.

23. The method of claim 19, further comprising forming a dielectric layer between the inner interconnect and the outer interconnect.

24. The method of claim 19, further comprising forming a mold surrounding the outer interconnect.

25. The method of claim 19, wherein the inner interconnect is configured to provide an electrical path for a power signal in a first direction.

26. The method of claim 25, wherein the outer interconnect is configured to provide an electrical path for a grounding signal in a second direction.

27. The method of claim 26, wherein the second direction is different from the first direction.

28. The method of claim 19, wherein the integrated device comprises one of at least an interposer, a package device, and/or a package-on-package (PoP) device.

29. The method of claim 19, wherein the integrated device is incorporated into at least one of a music player, a video player, an entertainment unit, a navigation device, a communications device, a mobile device, a mobile phone, a smartphone, a personal digital assistant, a fixed location terminal, a tablet computer, and/or a laptop computer.

* * * * *